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SZECHWAN DURING THE WAR

H. L. RICHARDSON

Evening Meeting of the Society, 16 April 1945

CHINA IS a land of contrasts. In Szechwan during the war, the most striking contrast was that between ancient and modern: between the China described by Marco Polo, still medieval in the twentieth century, and the new China that is anxious to take a place among the leading nations of the world. The war situation intensified this contrast: at the beginning of the present war (which, it should not be forgotten, began in China as early as 1937) Szechwan was the most backward of the important provinces of China; all through the war the Central Government has had to struggle to bring Szechwan more up to date, even while the major struggle with the Japanese has been going on. This explains some of the curious paradoxes that will be referred to later.

It also explains another fact of life in wartime China, which may be expressed by saying that while there I alternated between two moods: wonder at what was being done, in spite of all the difficulties; and dismay because so many things were being done so badly. Similarly in the reporting of China abroad there have been various periods of uncritical admiration for China's prolonged resistance to Japan, alternating with periods of severe criticism because the resistance is not more effective or appears to be hampered by internal problems.

It is well known how slender China's resources have been, in everything except man-power and the will to resist. Once the Japanese had penetrated and partly occupied eastern and central China, no large-scale industries or manufactures remained to produce the munitions of war; and all the densely populated and fertile provinces were gone, with one exception—the Red Basin of Szechwan. Of the western provinces, Szechwan is the only one with a population of over twenty million, or an average population density of over two hundred per square mile. It was the only unoccupied province in China with sufficient resources to enable even a delaying war to be waged against Japan. Further it was magnificently protected against invading armies by

mountains; and mountains have proved an even greater obstacle than oceans to the advance of mechanized armies in this world war. The Red Basin has been in fact the heart of China during the war years.

Thus Szechwan well merits study from the point of view of understanding China's position in the war. At the same time, the Red Basin is a fascinating geographical unit in itself, perhaps the most remarkable of its kind in the world. This paper presents briefly the human and physical geography of Szechwan, and thus gives a picture of the background against which the drama of China's war effort has been played: the life of the people, the difficulties that have been met with, the attempts to modernize a backward area and to make it yet more fertile and productive. Like any realistic picture, we must include both light and shade. A disservice has been done to China by reporting only the favourable things. The world has been led to expect too much, and has been disappointed when much did not materialize, through not understanding what conditions in China were really like.

Szechwan lies somewhat to the south of the centre of Greater China, but towards the west of China proper. Beyond it to the west lies Sikang, or Chinese Tibet, and then Tibet itself. It may be noted that Chungking is close to the great circle course between London and Sydney, and about half-way between these cities. This is a fact that may assume greater importance in the future, with the growth of air travel. An air-route between London, Moscow, Chungking, and Sydney would follow the great circle course almost exactly.[1]

Population figures for Szechwan, as for other parts of China, are only estimates: usually based on the number of households multiplied by an assumed factor for the average size of a household. I have heard estimates ranging from forty million to seventy million for the population of Szechwan. The official figure some years ago was forty-seven million, of which rather under one million were non-Chinese speaking or aboriginal tribes-people who live in the mountainous border regions of the south and west.

The area of the province is of the order of 160,000 square miles, pre-war estimates being rather greater than the present area of Szechwan because of the transfer of a part of the south-western corner to Sikang. The average population density is at least three hundred per square mile, the actual density being higher within the Red Basin but lower in the mountains. Thus in size and population, Szechwan occupies an intermediate position between Italy and pre-war Germany.

The Red Basin and its borders

The whole of Szechwan drains into the Yangtze Kiang or its tributaries, and the province is in a general way basin-shaped, being lowest where the main Yangtze valley runs, rather to the south of the centre, and highest around the borders. The mountainous borders consist of ancient rocks, but most of the floor of the basin is made up of reddish, Cretaceous, clay-shales and sandstones. They give the landscape a predominantly red colour, a little like that of the Old Red Sandstone or the Keuper Marls of Britain, though with a distinctly purple tint. Thus von Richthofen coined the name of Red Basin, which was so aptly descriptive that it has been used ever since. Soil scientists

[1] "The geography of post-war air routes: Discussion" (*Geogr. J.* 103 (1944) 89).

Red Basin: eastern border, Windbox gorge, Yangtze Kiang, near Fengkieh

Red Basin: western border, Omei Shan, Wanfuting from Chinting

however emphasize the purple tint of the soils, to distinguish them from the tropical red earths, which have entirely different properties. They classify the soils as belonging to a Purple-brown Group. Indeed, after living within the Red Basin for a while, I felt that perhaps W. H. Hudson's "the Purple Land" might describe Szechwan as well as the part of South America for which it was used.

The basin shape of the province can readily be appreciated from the sketch-map. This shows the lower land in the centre and the mountains around the borders, as well as the manner in which the mountains close in on the Yangtze river, so that it both enters and leaves the province through deep valleys and immense gorges.

The floor of the Basin is usually far from level (with the single exception of the Chengtu Plain), but it is relatively low everywhere except in the occasional anticlinal ridges. The sides of the Basin are not always very high; the lowest pass would be about 4500 feet, but the western ranges rise to 20,000 feet and more where they border the Tibetan plateau. Even where the mountains around the basin are low, as in some parts of the north and south, the country is very complex, with range after range of hills and mountains, and deep valleys between. Thus road-making is a matter of great difficulty, and the roads could be easily defended, even against a mechanized army.

The western border ranges make up a fascinating complex of deep valleys and high mountains. They adjoin the Szechwan–Sikang border, and mark the eastern edge of the Tibetan plateau; in this region the average altitude of the plateau is around 15,000 feet and the crest of the border ranges is 17,000 feet or over, with a few lower passes of some 15,000 feet. Many of the peaks are snow-capped all the year, while Minya Konka, 24,900 feet, with its glaciers, although lying in Sikang province, is a part of the same general system. There seems to be no one name for the whole mountain system; they might well be called the Sino-Tibetan Alps, except that a similar name was used earlier by Gregory for the ranges in or near north-west Yunnan.[1] The really high peaks and ranges stand back at a distance from the Red Basin, and at the edge of the Basin there are lower mountains or ranges of some 10,000–13,000 feet in height. The best known of these is the beautiful Omei Shan, 10,200 feet, near Loshan (Kiating), a mountain sacred to the Buddhists and a scene of pilgrimage with many temples. One can stand on its summit, looking towards the sunrise, with sheer cliffs dropping for a mile and all agricultural China stretching eastwards to the sea.

The Yangtze is already a large river when it reaches Szechwan, being about half-way between its source and the sea. Its major tributaries are also large rivers; the name "Szechwan" (Four Streams) refers to the four largest rivers, Kinsha Kiang (the Upper Yangtze), Min Kiang, To Kiang, and Kialing Kiang. In the past the chief way into the province was by boat up the Yangtze river, and this route is one of great difficulty because of the rapids and immense gorges. The river is subject to violent floods in the summer (the wet season), when it may rise 50 feet in a night, or even 100 or 200 feet in the gorges. During these floods large amounts of mud are carried down to the sea or to the alluvial plains of east China: it has been estimated that 300 million

[1] J. W. Gregory, 'To the Alps of Chinese Tibet.' London, 1923.

tons of silt per year are lost from Szechwan and carried down these gorges, equivalent to the erosion of 300,000 acres of good top soil.

Within the Basin most of the land is cultivated, but in the mountainous borders there is much uncultivated land, generally under scrub or small trees. Few forests remain, except in remote mountain regions. The climate of the Basin, which lies around 30° N., is classed as warm temperate: it becomes quite hot and humid in the summer, while winters have occasional frosts and very rare snow. The rainfall of the Basin, averaging around 40 inches per year, is higher than would be anticipated in such an area of low land, far inland and entirely surrounded by mountains, but there are occasional dry seasons, especially spring droughts, which lead to partial crop failures. Any famines that follow are only local however; it is this fortunate combination of a mild, moist climate with an inherently fertile soil that has made it possible for the Basin to support so large a population, and thus to endure the war years with only negligible food imports from outside the province. Another feature of the climate is its cloudiness. For long periods, especially in the winter, there is a roof of cloud over the Basin which protects it from the frosts and the evaporation that would otherwise lower the yield of winter crops. The cloudiness of Szechwan is well known to the rest of China, which has a saying that "In Szechwan, the dogs bark when they see the sun" (as they would bark at any other stranger).

The irrigation of the Chengtu Plain

The Chengtu Plain, as well as being the only extensive area of level land in the Red Basin, is also the most productive. In origin it is a piedmont alluvial plain, and it slopes gently towards the south. Within an area of some 40 miles by 50 miles it supports a population of about five million people, and four million of these live directly on the land: a farming population of two thousand per square mile. This must be nearly a world's record; it is also a very valuable thing for Szechwan to have such a large, relatively prosperous, population which is unaffected by drought. The immunity from drought and flooding depends on the ancient irrigation system of the Plain. This is perhaps the most remarkable in the world, apart from that of the Nile valley, because it was installed about 300 B.C. and has continued to function ever since. The water comes chiefly from the Min river, where it leaves the mountains at Kwanhsien, although other smaller rivers also contribute.

At Kwanhsien the main intake of the system consists of boulder banks that split the Min river into two parts, along with an adjustable barrage of timber. A mile or so downstream from this is a permanent intake channel which has been cut through a neck of hard conglomerate rock, a sort of natural concrete. This channel has endured ever since it was first cut, and it controls and defines the flow of the river waters that enter farther upstream. Every year, in late winter when the flow is at its lowest, the water is temporarily barred off from the main canal; any gravel deposited is removed and the channel is cleared down to the level of a set of metal bars embedded in the hard rock; any silted channels in the rest of the system are also cleared. Then, at about our Easter time, the barrier is re-opened with great ceremonial, in which the governor of the province takes part—The Opening of the Waters.

Red Basin: near the centre, rolling country, Neikiang

Red Basin: northern border, north of Kwangyuan

The two thousand year-old intake of irrigation system at Kwanhsien: Elephant's Nose temple

Bifurcation of minor irrigation canals on the plain, near Chengtu

Below Kwanhsien, the water is distributed through countless bifurcations of the canals, and of the rivers that have been embraced in the system; the minor canals also anastomose and flow into larger channels, from which water is again taken off, so that the irrigation channels are thrown over the great plain like a net. The endurance of the system may be traced to two things: the intake cut in solid rock; and the faithful observance of a message left by Li Ping, who founded the system so long ago. His message, now engraved on the wall of the Erh Wang Miao Temple that overlooks the upper intake, says "Deep dig ditch, low make bank"—Dig the channels deep and keep the banks low, a slogan that might well be adopted by large irrigation systems in other parts of the world, where a burst canal bank sometimes brings much trouble.

Town and village life in Szechwan

Compared with east China, Szechwan was a backward province before the war; the amount of dirt and disease, the insecurity of life, the rough manners of the people, and their often poor way of living, shocked the "down-river" Chinese when they came to Szechwan early in the war. Country life had for centuries continued along the traditional lines, and in many ways it still does so: astrology and magic, devils or ghosts and exorcisms; religious, wedding, and funeral processions; dragon processions for rain—such things made up a large part of the life and entertainment of the country folk. The position of women however improved after the revolution; in particular, foot-binding had ceased by the 1920's. Further the organized religion of the Buddhist, Taoist, and Confucian temples lost much of its grip. The temples themselves were often taken over by the military or civil power, for headquarters, offices, or schools; the land-holding temples lost much of their land; and temples not taken over were usually sadly decrepit. The most prosperous and best-kept temples were those in the western mountains, particularly at Omei and Kwanhsien, which served as hostelries for pilgrims, and summer resorts for visitors from the plains. These have maintained and even increased their prosperity during the war, because more of the wealthy official class, especially the people from "down-river," have been using them as summer resorts.

The phrase "down-river people" is constantly in the mouths of the Szechwanese: it is illuminating as indicating the importance of the Yangtze river route into and out of the province. It suggests too the "insular" mentality of the Szechwanese people, which has made the path of the Central Government much harder during the war years. Especially in the earlier years of the war, the people from east China looked down on the Szechwanese, and the Szechwanese did not like them very much either. However, further acquaintance, and the knowledge that there was Japan, the common enemy, to be resisted, tended to overcome these differences which were, after all, mainly superficial.

Szechwan differs from some other parts of China, particularly the north, in that the closed or walled type of village, in which most of the farmers there live, is little developed. Farmers usually live in separate farmsteads, on their farms, scattered about the countryside. Villages exist as shopping centres or places of rest for porters or other travellers, as well as places where farmers may meet at a tea-shop. The larger villages are in fact market towns;

and of market towns in turn there is a great range, from settlements of a few dozen houses to large cities. One common characteristic of all except the largest towns is the tendency to be strung out along one or two main streets, very like an old English village.

As might be expected from the relatively dense population of the Basin, towns and even cities are numerous; there are something like one hundred and fifty *hsien* or counties, each with its own county town: and this is often quite a large town with a population measured in tens of thousands. It surprises the traveller at first, how often, after travelling for long distances that may appear to be off the beaten track, he will come to a large and flourishing city, more or less self-contained and independent, prosperous and stocked with merchandise. Most of these large cities are on the great rivers, which have supplied the chief means of transport of heavy goods until the last decade. These cities have a life of their own, although they have been more affected by the war situation than has the countryside. Roads have now been built to them; secondary schools and research stations have been installed; other modern ideas, including police systems, wider streets, electric light, some modernized shop-fronts, government-sponsored newspapers or news sheets, and intensive war propaganda, have followed. Some have become the site of wartime manufactures, including arsenals; some have suffered severely in air raids. The old cities were always walled, but gaps have been made for air-raid exits during the war.

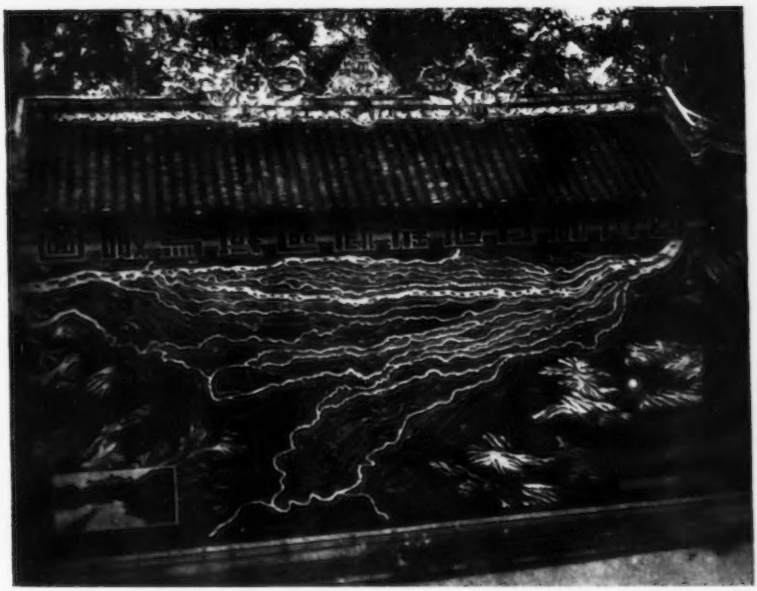
The total population of these large towns and cities is no more than a fifth of that of the province as a whole; four-fifths of the people live either on the land or in small rural villages. To these the war has brought much less change, apart from the conscripting of their sons for military service, and wartime modifications in taxation. Small primary schools have been introduced widely through the country, often in old temples, as well as in the cities; and there is some wartime propaganda; but it may be doubted whether the war plays a big part in the thoughts of these country people. Their problem, like that of all peasant communities, is first to cultivate the land, and to live.

Much of the country people's time is spent on their farms; much is spent also at market and in the tea-shops which are a feature of all Szechwan life. These tea-shops are social centres, places of bargaining and business, and even temporary courts of justice, in which small local quarrels are tried and adjusted by the neighbours, according to immemorial custom. For a while, it was said, the Central Government tried to suppress the Szechwan tea-shops, as being places where too much time was wasted: but they still survive undiminished.

It may be noted that there is a good deal of informal democracy in the administration of local affairs in Szechwan, at the village or small-town level; but above this level, in the counties or cities and their major subdivisions, the administration is autocratic, in the hands of officials, including "hsien magistrates," appointed by the Provincial Government acting sometimes on the advice of the Central Government. In country districts the inhabitants are still very much at the mercy of a bad official, just as they may benefit from the self-sacrificing service of a good one.

My introduction to Szechwan was seeing the stoning of a corrupt magistrate at a border town of the province. After sleeping the night at the town, we had

Yangtze Kiang at Chungking, looking towards south bank



Diagrammatic map of Chengtu plain irrigation system on the Erh Wang Miao temple, Kwanhsien

Hoeing stubble

Szechwan plough

Farming near Chengtu

Threshing rice

Farming near Chengtu

to ferry across a river in order to proceed next morning; we were held up there by a mob of townspeople who were anxious to make sure that the magistrate was not on our vehicle. Later the magistrate came down onto the beach of the river (with a small escort of soldiers), and by dint of firing his revolver in the air he progressed to the edge of the river. But when he tried to board a boat none of the boatmen would take him and the crowd threw stones at him, in a rather half-hearted fashion it is true. So finally he went back to the city. We heard later that a company of soldiers had been sent from the district headquarters to enable him to leave. His offence, in local eyes, was not simply that of taking "squeeze," but of unreasonable rapacity. The idea of the townspeople had been to get him to disgorge some of his ill-gotten gains before he left, his term of office having been completed.

Under the influence of the Central Government it is to be hoped that the number of such magistrates has decreased during the war; but it must be admitted that Szechwanese local politics are such that an honest and impartial magistrate may not have an easy time in certain districts; and if, as is almost inevitable, he antagonizes the local landowners and secret societies, he may be forced to leave.

Farming in Szechwan

Farming, as the occupation of four-fifths of the people, and the chief source of wealth of the province, deserves more space than it can be given here. However it is similar in many respects to the agriculture of other parts of central and southern China. An outstanding thing about Szechwan is the wide variety of crops, as well as of economic trees, which can be grown. It has been said, somewhat loosely, that every crop which is grown anywhere in China can be found in Szechwan: this is certainly true for the major crops and trees, although some frost-sensitive species, like pineapple, are not found there.

Rice is the most important crop, both in the area of land occupied (about half the cultivated area of the province) and in importance for food production. Many other crops are also relied on, to a greater or less degree, for food, especially by the farmers: these crops include wheat, beans of many kinds, and peas; sweet potatoes, maize, and pea-nuts; Irish potatoes in the mountains; garden vegetables; barley and various minor cereals, and condiments. Oil seeds, notably rape-seed, are important for cooking and illumination (especially in wartime); economic crops include cotton, sugar-cane, tea, mulberry, tung oil, tobacco, and various rather rare products such as indigo, lacquer-varnish, and the white wax which is derived from a scale insect. Green manure and fodder crops are also grown.

Within the Basin there is a clear distinction between winter and summer crops, most of the crops familiar to us in England being grown in Szechwan as winter crops. They are harvested in the spring, and summer crops are then sown—these are crops that will not usually grow or ripen in England, such as rice, maize, soy-beans, sugar cane, cotton, and sweet potatoes. Fuller data about cropping and economic plants in Szechwan are available from many sources, including Hosie's 'Three years in Western China' (1890),[1] J. L. Buck's 'Land utilisation in China' (1937), and the present writer's monograph

[1] Also A. Hosie, 'Szechwan: its products, industries, and resources.' Shanghai, 1922.

'Soils and agriculture of Szechwan' (1942). With reference to Buck's valuable account, it may be pointed out that in the early 1930's, when his field surveys were made, the opium poppy was an important crop in Szechwan, occupying no less than 11 per cent. of the crop area each winter. The growing of opium has been entirely suppressed in Szechwan in recent years, by the strict measures enforced by the Central Government, and its place has been taken by rape-seed, wheat, or other food crops. This has doubtless contributed to the favourable food position of the province during the war.

Although double-cropping (growing two crops in the course of the year) is common in Szechwan, much of the land grows only one crop, notably the rice-paddy fields which are kept flooded in winter, unless a source of irrigation water is available. The "double-cropping index" for the province is only 167 per cent., *i.e.* about two-thirds of the cultivated land grows two crops in the year. Travellers' tales about three or even five crops being grown annually can only apply to very special and unusual conditions, such as market gardening. There is however a good deal of mixed cropping: that is to say, growing two or more crops in alternate rows. Cereals and leguminous plants, in particular, are grown in this way.

Cultivation operations are similar to those in other parts of China, so they need not be gone into in detail. The Szechwanese, like most other Chinese farmers, handle their fields very well for intensive cultivation, often planting seeds in separately manured "hills," rather than broadcasting them; transplanting rice and other crops from seedbeds; and keeping weeds down. Their cultural methods often reminded me more of market gardening than of English farming. Of course the farms are small (the average cropped area is 3·1 acres) and so are the fields. Much hand labour is used, both in cultivating with heavy hoes, and in harvesting with sickles. Ploughing is usual on the larger fields, the plough used on the Chengtu plain as well as other parts of the province being noteworthy for its simple and efficient design. The "beam" is a single piece of wood, cut from a tree trunk (trees are sometimes trained to the shape desired, or bent trees may be found growing wild); at its rear end a second, downward-pointing piece of wood carries a hand-grip at one end and the ploughshare at the other; the ploughshare is a simple iron blade, and a furrow is turned merely by tilting the whole plough to one side. There must be a nice balance of forces in the design in order to plough a good furrow in this way, but the result in the hands of a capable ploughman could hardly be bettered.

Mention may be made also of the simple method used in threshing rice: the sheaves are beaten directly against the sides of a square wooden tub, and this is sufficient to dislodge the grain, which collects in the bottom of the tub while the straw is put aside for later use. Rice straw has considerable value as a feed for buffaloes and other livestock, as a thatching material, and as a fuel.

Most crop residues are used in one or more of these ways, with the result that not enough is returned to the soil as manure, and there is consequently a shortage of organic matter in Szechwan soils, like those of most other parts of China. The usual manure employed in Szechwan is diluted night-soil; animal droppings are also used, but they contain little in the way of bulky litter (as does English farmyard manure), and when they are composted by

the farmers they are mixed with ashes or earth, not with straw. Other waste products, including oil-seed cakes and bone meal, as well as ashes, are used as manure, but the supplies are small. Consequently, although average crop yields in Szechwan compare favourably with those, say, in India, they are considerably below the English level for comparable crops.

The Red Basin of Szechwan has an almost legendary reputation for its fertility, but as in other legends there has been some exaggeration. To take a representative crop, the average yield of wheat, in Buck's survey, was 23 bushels per acre, which is higher than the average for most of China, but far below that for Britain. Farmers maintain fertility to the best of their ability by the use of the limited amounts of local manures, but there is no way of increasing these substantially. The high fertility of the Chengtu Plain depends on the regular water supply and on regular additions of silt from the irrigation water, as well as on manuring; the continued productivity of the other soils of the Basin is due to the fact that in spite of heavy erosion, the subsoil materials and parent rocks (soft shales and sandstones) readily weather into fresh soil, fairly well supplied with mineral plant foods. With these basic factors to help them, the farmers have been able to maintain the fertility at a moderate level. But if it had not been for the softness of the rocks of the Red Basin, and the ready formation of new soil, Szechwan would have been little more productive than the other hilly provinces of south China. Field experiments carried out during the war have shown that large increases in crop yields can be brought about in Szechwan by the use of artificial fertilisers, in addition to the local manures, and it is likely that after the war these fertilisers will be both imported and manufactured within the province.

As might be expected from the small size of their farms, Szechwan farmers are poor in comparison with those of parts of the world where larger farms are the rule. Their condition has however very noticeably improved during the war, under better government than that which they enjoyed previously. In the 1920's and early 1930's, under a succession of rapacious war lords and their armies, with occasional civil wars, the farmers were reduced to a very low ebb; taxes, for example, were collected for thirty or fifty years ahead. When I first reached Szechwan in 1938, the Szechwanese farmers appeared poorly clad and under-nourished in comparison with those of some other provinces. During the war years however although fairly heavy taxes had to be imposed they were not so heavy as those of the old war lords, or at least they were collected more equitably. Prices also have been at a high level, and even when the catastrophic rise in prices took place which has imposed so much hardship on the educated classes, the farmers on the whole benefited rather than otherwise. Probably the chief hardship felt by the Szechwan farmers as the result of the war has been the conscripting of their sons into the army. This, of course, was unavoidable; but in spite of the conscription one has the impression that the man-power of Szechwan has suffered relatively less depletion than that of Britain or the British Commonwealth.

Local industries

Before the war, Szechwan had practically no large industries or modern factories, the nearest to a large industry being the preparation of salt from

brines found underground in various parts of the province. There was, on the other hand, a considerable range of local industries and crafts, carried on in a small way with human labour. Iron, copper, and lead were mined and smelted; gold was washed out of the sands and gravels of the great rivers; coal was mined in simple shafts, and coke was burned like charcoal in outdoor heaps; charcoal itself was prepared by burning scrub or saplings; lime was roasted; potash was prepared by burning the cut growth on meadows in the western mountains, and leaching the ashes; nitre or salt-petre was prepared from nitre-impregnated earth, found in old courtyards or walls; sulphur was obtained by roasting sulphide ores. These, with the salt, were the foundations of chemical and metallurgical industries in the province. Every city or large town had its own blacksmiths, coppersmiths, and manufacturers of pewter-ware; earthenware and rough porcelain were produced in various parts of the province; cabinet makers and lacquer-varnishers were to be found in every town. Compared with north and east China, the general level of craftsmanship was poor, but the products were serviceable or easily replaced. Much ingenuity was displayed in the use of bamboo, not only in house building and for making furniture, but for less conventional uses such as long, strong ropes for hauling junks up the rivers; and for the straps, buckets, and pipes employed in the salt industry.

Spinning of cotton or silk (wool was almost unused before the war) was mostly carried out at home, as a spare time occupation for both farm and town women; weaving was done on small hand- or foot-power looms. Cotton fabrics were usually rather coarse and rough, but some very fine silks and brocades were made, and elaborate embroidery of more than one type was worked. In addition to the usual highly-coloured dragons embroidered on silk, there was a very interesting class of "blue-thread work" done in cross-stitch on cotton, a peasant art with an entirely different conception of design.

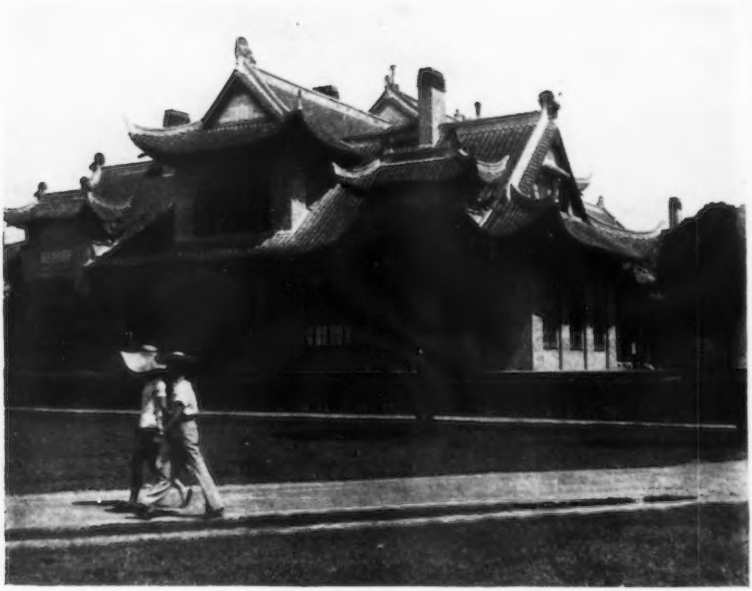
Thus practically everything in everyday use in the province before the war was made locally: the most noteworthy exceptions were enamelled basins, paraffin or kerosene lamps, thermos flasks, electric torches, and toilet soap. In the bigger cities too there was a fair range of manufactured goods brought up the Yangtze river from Shanghai. Already before the war a few steps had been made to introduce larger or more efficient factories: for example steam-power electric light plants, silk filatures, arsenals for local war lords, and one modern iron and steel smelting plant. Political and other uncertainties had however prevented these from going ahead or developing to any degree.

At the beginning of the war in eastern China great efforts were made to transplant factories and equipment from the north or east to Szechwan. Appreciable amounts were brought in, although transport difficulties were immense; an industrial suburb has grown up near Chungking, but it has not proved possible to build up anything like the degree of industrial production existing in Shanghai and Hankow. One difficulty was that with the ever-tightening Japanese blockade, the heavy machinery, which had to be imported before a start could be made, was prevented entry or was cut off in transit. Another trouble was the ever-rising price level, which finally involved a

Bus crossing To Kiang by ferry, near Neikiang

Brine wells and salt factories, Tzeliutsing

Interior of salt factory: evaporating brine by heat from natural gas, Tzeliutsing



West China Union University, Chengtu: Administration building, with students

Szechwan tea-shop, Laochunchang

fantastic level of capitalization for even a moderate enterprise, and produced an equally fantastic wage bill. The great amount of human labour employed in Szechwan for mining, transport, and at every stage of the process even with a modernized industry, aggravated the situation. I was told, for example, that a steel works of quite moderate capacity had to close down because, in all, it required the labour of fifty thousand coolies to keep it in production.

Thus, while some modern-type factories were certainly established in Szechwan during the war, including arsenals, cotton-mills, heavy chemical works, and alcohol distilleries (for power alcohol), the degree of development was nothing like sufficient to run a modern war. Smaller industries involving only hand labour were much more successful, and in the course of the war it became possible to buy many household goods of modern type, such as tinned foods and condensed milk, woollen goods, electrical equipment (including lamps, torch batteries, and even transformers), glassware, and scientific instruments, which were not made in Szechwan before the war. Private enterprise had a considerable part in this, and so also did the Chinese Industrial Cooperatives, about which much has already been written. The Cooperatives undoubtedly did much to raise production directly in the early years of the war, and also to stimulate the production of new products by private enterprise, but in later years they met difficulties of an administrative and political nature. They also were hard hit by the effects of rising prices, including the necessity for heavier capitalization.

Transport

The old roads of Szechwan were foot-paths or mule tracks, usually paved with a narrow pavement of stone flags: "Good for ten years and bad for ten thousand," as the Chinese saying is. These roads still survive throughout the province, and they still carry much traffic of the traditional pattern: coolies with carrying-poles, foot-passengers, and passengers in litters or sedan chairs (*huakans*), occasional mule-trains (rare except in the mountains or near the salt mines), and wheelbarrows—the last-named restricted to the plains. These old roads were used chiefly for local journeys or for the local distribution of goods. Longer journeys, and especially the distant transport of heavy or bulky materials, were made by boat. The pattern of large rivers in the province and their tributaries, as well as the larger canals on the Chengtu plain, made water transport the method of first importance, as it doubtless has been for many centuries. All heavy goods that came into the province came up the Yangtze river, through all the gorges and up all the cataracts.

To travel on the old roads, or on the rivers, by the ancient means is the way to get to know Szechwan. A motorist on the new roads, provided he is not unlucky in the matter of breakdowns, may leave a comfortable house one morning, lunch in a good restaurant, perhaps spend the night at a decent guest house, and next day arrive at his destination. He learns little about the realities of every-day life in the province. But travelling slowly across the country, on foot or by litter, drinking green tea in tea-shops once an hour, eating odd meals in little food shops, and spending night after night in odorous, unclean inns: this is to learn how the ordinary people live. On the way, one may stop to talk to farmers and visit their farms; during the halts,

or at night, sick people come to beg treatment or medicine (which most Western travellers carry with them); while travelling there is time to look at every field and to estimate the condition of the soil and the crops.

Modern transport has come late to Szechwan. Not until after the 1914–18 war did motor roads appear, and there is still no railway in the province, although a beginning has been made in constructing the road-bed for one. Areoplanes reached the province before trains. The first motor roads began to be built by progressive generals in the 1920's. At first these roads ran only within the province, and they carried little motor traffic except a few broken-down buses, although they were largely used by the old forms of transport, and rickshas started to appear. When the Generalissimo visited Szechwan in 1935, and began to form plans for using the province as the heart of Free China in the event of Japanese attack, he undoubtedly stimulated the whole road-building programme; notably the construction of the long and difficult roads over the mountainous rim of the Basin. The result was that just before the present war began, it was already possible to reach Szechwan by motor road from the north (Sian (Changan) and Nancheng (Hanchung)), or from the south (Kunming or Kweilin and Kweiyang), and to motor from Chungking to Chengtu as well as on various subsidiary routes.

During the war, road building continued steadily and some great feats of construction, fully comparable with the Burma Road, have been carried out. In consequence there are now other roads connecting Szechwan to the south (particularly a more direct way to Kunming, via Luhsien (Luchow) and Weining), to Sikang, and to the north, as well as quite an extensive network of roads within the province. However road surfaces are poor; the major roads have a macadam surface, but they are always badly potholed; and minor roads are simply dirt tracks, with a most exasperating absence of bridges or presence of broken culverts. Farmers on a minor road, too, often cut ditches across the road to carry water to their rice fields. To give an idea of the nature of the surface, it may be mentioned that the first two jeeps that travelled over the main road from Chungking to Chengtu were both held up by broken springs.

Early in the war, especially when supplies began to come in freely from the U.S.A., motor transport was quite well developed in Szechwan. Private or official cars were common, motor-trucks, both public and private, were still more numerous, and motor-buses flourished although by our standards they were uncomfortable and overcrowded. However even then there were frequent delays—including those due to ferrying over rivers, none of the larger rivers being bridged—and breakdowns were common as a result of the lack of experience of drivers and mechanics. Most trucks carried both a driver and a mechanic: the driver would drive, but would not do repairs; the mechanic, if willing, was rarely capable; only too often he was unwilling, or the tool-kit was so deficient that he could do nothing.

There was also a regrettable frequency of accidents, as travellers on the Burma Road have recorded. I speak feelingly, as I had to spend two months on my back as the result of a motor truck, on which I was a passenger, overturning. Most other members of my Department in the Agricultural Research Bureau had also been involved, as passengers, in road accidents, some with

serious consequences. Agricultural research necessitates much travelling, and we began to say that road accidents were the "occupational risk" of agriculturalists.

These accidents were largely due to inexperience and rashness on the part of the drivers: most of them had probably never seen a piece of heavy machinery until they started to drive; and, in particular, they failed to appreciate the powers of momentum. But perhaps the wonderful thing is not that there were so many accidents, but that large-scale motor transport was carried on at all.

Other forms of road transport developed also, making use of the motor roads: rickshas travelled surprising distances on long cross-country journeys —a single puller would travel 100 miles in three or four days, or by changing rickshas one could make even better time. Mule carts began to be used, especially those coming in from Shensi with cotton; and "flat-carts" pulled and pushed by several sweating, but cheerful, coolies took part in both short and long hauls. Curiously, horse-transport for either goods or passengers was late in appearing, but by mid-1943 there was a brisk service of pony-carts carrying passengers between Chungking and its suburbs, and after negotiation someone might be found willing to make the whole journey from Chungking to Chengtu.

It was fortunate that these alternative forms of road transport developed, because as the war progressed motor transport declined and became less and less reliable. The vehicles always did wear out rather rapidly under Chinese conditions, without adequate care or workshops; this did not matter so much when fresh vehicles were coming in from outside, but once the Burma Road was closed the number of vehicles on the roads steadily fell. Transport by road became correspondingly hard to get, and the journeys were still more frequently delayed by breakdowns.

Motor fuel was also a difficulty, but from early in the war the Central Government had given much attention to encouraging local sources of production. Although petroleum is said to occur in association with the brines of Szechwan, very little has yet been produced or refined. On the other hand, the production of power alcohol, in the first place from molasses, reached large proportions. In fact there was a regular boom in alcohol factories (built from local materials, with the help of steel from oil drums): the production of alcohol outstripped consumption, so that some of the firms went bankrupt. Local vegetable oils, including rape-seed oil and tung oil, were put through a "cracking" process to yield motor fuel, and they were also burned directly in diesel engines. Charcoal or converter gas units were also attached to many trucks and buses. They suffered from two disadvantages: low power on the numerous hills; and rather rapid corrosion of engines, unless very efficient filters were fitted and kept in good condition.

The old standby, water transport, was not neglected during the war years. At first it suffered from competition with the more speedy motor transport, but as the latter declined, water transport came back into its own for heavy goods. During the war there was a government programme for constructing more junks to serve on the rivers of the province, and the service of small steamships and motor vessels above Chungking, which already existed before

the war, was augmented by vessels that came up from the lower Yangtze when that route was closed.

Transport by air had started before the war: a few airfields had been constructed in the province during the early 'thirties and there was a regular service from Chungking to Hankow and Shanghai. The air services were considerably enlarged as soon as the war developed and Szechwan became the centre of the Government; for some time both Eurasia (with German backing) and the China National Aviation Company (C.N.A.C., with American backing) ran regular routes; later, Eurasia practically dropped out. Chinese airlines have as good a record for safety as those anywhere, thanks to rigorous inspection and perhaps to some degree of foreign control; experienced Chinese airline pilots proved fully as capable as those from abroad. As the war went on, and planes wore out, the air services became somewhat contracted; at the same time the decline in road transport meant that more people wanted to travel by air; thus unless one had an official priority it was necessary, as in other countries, to book far ahead. There was a saying that if you were really in a hurry to go anywhere, the quickest way was to walk: it might take a week or two, but you would be sure to get there within that time. If you wanted to go by bus, you might have to wait a fortnight for a ticket and then spend a week on the road because of breakdowns; if you flew, the journey would certainly take only an hour or two, but you would have to wait a month for a place on a plane.

Despite its safety, air travel in Szechwan offers some excitement. The landing-field at Chungking, for example, which is used when the river-level is low, is no more than a single long paved strip on the gravel beach of the river. The river lies at the bottom of a deep valley, with hills rising 1000 feet not far away; the hills are quite often under cloud, while in the other direction, high-tension power lines span the river. Approaching and leaving Chungking by air under these conditions is liable to produce a feeling of suspense in the passenger. On one occasion, I was travelling in a small flying-boat on the upper Yangtze; after calling at a certain port, there was only one direction in which the plane could take off, because of the formation of the hills; this direction happened to be against the current of the river, which was in spate. Some distance upstream was a fair-sized cataract or rapid, and the plane made two futile attempts to leave the water, in the course of which it bumped over the cataract in the most alarming fashion, before finally getting into the air at the third attempt. However although the flying-boat looked decrepit, it held together and the pilot kept his head, and all was well.

The construction of military aerodromes proceeded apace during the war years, notably on the Chengtu Plain. The almost level but well-drained surface of the plain proved ideal for aerodromes, though some of the local farmers were bitter at the loss of good rice land. In the earlier years of the war there were not sufficient planes and pilots to make full use of these fields, but they were constructed with a definite eye to the future, and it is no secret that some of the early Super-fortress raids on Japan took off from Szechwan aerodromes. If sub-stratosphere flying becomes a regular thing, the direct route between India and Chengtu, across the Sikang Plateau, may become important, for it is only a matter of 500 miles.

Recent history in Szechwan

It is frequently said that the Chinese Revolution of 1911 started in Szechwan, though it started there in a thoroughly Szechwanese fashion: a railway to Szechwan up the Yangtze valley had been proposed, and indeed a railway station and a memorial pillar were constructed. But the Manchu Government wanted to build the railway in its own manner, and the Szechwanese did not want a railway unless it was financed and managed by Szechwan; tempers grew warm, fighting started, the Manchu governor of the province found that he had more than he could handle; the trouble spread to other provinces, which were already ripe for rebellion, and the Dynasty fell.[1]

After that there was a long period of turmoil in Szechwan province, while rival Szechwanese generals and some from outside provinces struggled for power. On one occasion Szechwan was invaded by a Yunnanese army; civil war flared up and died down again at intervals; there were occasional anti-foreign outbreaks. It was an unhappy period for Szechwan, and helps to explain why the province was relatively so backward at the beginning of the Sino-Japanese war. Generalissimo Chiang Kai-shek and his government had little authority in the province until 1935, when the communist bands, on their "Long march" from Kiangsi to Kansu and Shensi, passed through the mountainous borders. Then the Central Government brought in troops, built block-houses and forts, ordered more roads constructed, and generally, while pursuing the communists, contrived to assert its authority and bring order to the province. The position was still an uneasy one up to the outbreak of the Sino-Japanese war, simultaneously with which the then governor of the province (the most successful of the war lords) died of heart trouble. This and the transfer of the capital from Nanking to Chungking simplified the task of the Central Government in securing effective control of the province.

The provincial capital remained in Chengtu, even after Chungking became the national capital. The governor of the province was nominated by the Central Government, but he had to be a man acceptable to the Szechwanese leaders, and there was also a military governor, or "Pacification Commissioner," in the person of the best of the old war lords. Even during the war years there were occasional mutterings of discontent from the old provincial authorities, and a few minor incidents reached the surface. The need to deal delicately with the matter of provincial autonomy (some of the other provinces being even more troublesome than Szechwan in this respect), must have immensely complicated the war problems of the Generalissimo and the Central Government.

Szechwan politics are remarkably complicated. In the absence of representative government as we know it, much goes on beneath the surface, or finds expression through pressure groups, and no one from abroad can be expected to know all the ramifications. There are however still some generals left over from the old war-lord days who retain, if not private armies, at least large groups of soldiers under their personal control. There are also secret societies, notably the so-called "Long Gown Brotherhood" or *Ku-lao-huei*;

[1] S. C. Yang, "The revolution in Szechwan, 1911–12" (*J. West China Border Research Soc.* 6 (1933–34) 64–90).

their function varies even in the same organization between that of a Friendly Society in the English sense, and something like the Italian Camorra. The secret societies are not just an invention of the imaginative traveller; they undoubtedly exist, and have a large and influential membership throughout the province. They take a considerable hand in local politics, including making things easy or difficult for a new magistrate; they are not always free from suspicion of complicity with local bandits. Another, perhaps not altogether distinct, political group is that calling itself "The Szechwan Gentry." These are mostly large landowners, including some retired war lords who have gone in for land-owning. They represent the most conservative element in the local society, and, of course, they strongly protect local interests: their influence is said to have been marked at the time of the railway revolt.

These represent the forces in the background, which have to be opposed or conciliated when the Central Government wishes to introduce a greater degree of central control or other new measures. They may have considerable influence on the conduct of local government within the *Hsiens* or counties, even if the *hsien* magistrate happens to be a Central Government man. Their influence would also have to be taken into consideration in connection with any introduction of suffrage and extension of democracy in the province. They are, for example, strongly anti-communist, and any attempt to set up democratic party government in China, with the communists as one party, might meet with trouble from these Szechwanese groups as well as from the Kuomintang.

Perhaps it would be kinder not to say too much about banditry in Szechwan, since its prevalence must be attributed in part to the fact that the good soldiers are at the front, and bandits can only be suppressed with the help of good, well-armed troops. After the war, when such troops are available, the bandits may be quickly put down. It must be recorded however that there are bandits throughout the province, even on the closely settled Chengtu plain. On the more travelled routes, which are better guarded, they only molest an occasional traveller, especially if he has the bad judgment to be out after dark; but in more remote and mountainous districts they form a real menace, and there are places where it is not safe to travel without a guard; even some places where a small army is necessary for safe conduct.

In point of fact, the average English traveller avoids the worst places, and takes a chance on the others. In any case, Western travellers are less often molested than Chinese, perhaps because the courtesy of the Government is such that on the few recent occasions when Europeans have been robbed or injured, there has been much trouble for the bandits.

Life during the war

In spite of these local troubles, left over from the bad pre-war years, Szechwan has undoubtedly made a big contribution to the war of resistance against Japan. The province has supplied considerable numbers of troops, to reinforce the army's man-power, and it has been a source of military supplies. Despite its limited resources, it has supported a large number of refugees from east China, in addition to the Central Government itself. If the Central Government had not had Chungking, defended by its mountain ranges, to

come to after Hankow fell, it may be doubted whether they could have carried on the struggle.

Chungking, and life in Chungking, have been so often described by visiting correspondents that there is no need to say more about it here. Life there was lived under curious, difficult, and crowded conditions; but Chungking could not be considered representative of wartime Szechwan, any more than living in any other capital under constant air attack is typical of life in the country as a whole. Less so, if anything, because of the preponderance of the rural population in Szechwan, and the relatively small population of the capital city itself.

The coming of the Central Government to Chungking, and the improvements in local administration that ensued, were in turn of benefit to the province. The conversion of Chungking almost overnight from a treaty port to the capital of China was a remarkable feat, and it made a great difference to the immediately surrounding country, while ripples of influence spread over the whole province.

Wartime propaganda was organized throughout the province, even in remote areas, and education in primary and secondary (or "elementary" and "middle") schools has had a pronouncedly nationalistic trend. The new generation of Szechwanese will have an entirely different outlook on national and world affairs from their parents. Slogans and inscriptions in giant characters several feet high are to be seen everywhere, on the walls of towns and temples and public buildings; dynamic posters are painted up on other walls; wall-newspapers and mimeographed news-sheets are produced in quite small towns as well as in the cities.

The Japanese themselves have contributed to the feeling of national solidarity by bombing the Szechwan towns. Early in the war the Szechwanese disliked the "down-river people," suggesting that if they had only stayed where they belonged the Japanese would never have threatened Szechwan. But after the air-raids began, and continued, the people of Szechwan developed a personal dislike of the Japanese, which must undoubtedly have contributed to the help they gave the Central Government.

Some of the raids were bad, by any standard. The history of Chungking is now well known; the centre of the city was practically obliterated; whole new streets were laid out when the city was rebuilt; to one returning to the city after the rebuilding it was quite hard to find the way. Chengtu did not suffer quite so badly, though entire city blocks and many smaller areas were destroyed; most of the chief cities of the province were bombed more than once, as well as some smaller centres. The city of Loshan (Kiating), an important river port, was completely wiped out within the city wall, by a single incendiary raid. But, as in other countries where there is a tough fibre of resistance in the people, the Chinese in Szechwan and elsewhere have promptly set to work to rebuild the bombed areas, using at first temporary materials; later building in brick or mud walls; and hoping after the war to build in concrete.

After 1941, the Japanese were so busy using their planes elsewhere, and the American pilots stationed in Kunming had made attacks on China so costly, that Szechwan had a relatively peaceful time from air raids. From then

on, the steadily mounting cost of living became the chief personal preoccupation of those living in Szechwan. Ever since the Japanese closed the Yangtze at Ichang, and so cut off the main avenue by which goods from the outside (notably rice) entered the province, prices had been rising more steeply than in the first years of the war. The rate of rise in the cost of living index could be expressed with quite remarkable regularity on a logarithmic curve: on logarithmic-ruled paper it was almost a straight line, ascending month after month with minor fluctuations. The average rate of increase was a little under 10 per cent. per month: prices on the average doubled every eight months, or tripled every year.

It was very interesting to live in the midst of a gigantic economic experiment that proceeded with such regularity, but after two or three years people wondered how they could possibly manage if prices did not begin to fall soon; and the prices just kept on rising. They rose from several times pre-war to tens of times, and then to hundreds of times, and the whole thing just became fantastic. Those who had goods and chattels to sell were fortunate: one could live for several weeks, for example, on a portable gramophone.

As always during inflation periods, those who suffered most were the educated people living on salaries—they received cost-of-living bonuses, but these were never more than a small fraction of the rise in living costs. Early in the war the standard of honesty among government servants seemed high, but as the fantastic rise in living costs continued, an official had to adopt any means that would enable him and his family to survive: some occupied a plurality of posts, some took "squeeze" on an ever-increasing scale. This naturally lowered the standards of honesty in government and opened the way for other forms of corruption, which helps to explain the state of affairs that has received unfavourable comment from correspondents in China during recent years. Students also suffered from the rising living costs and hence from undernourishment; because of this and overcrowding, tuberculosis claimed progressively more victims as the war went on.

Farmers, merchants, and coolies were not so badly off; their cash intake rose with the cost of living, and some of them kept a little ahead of it. Among such people there was a sort of false boom, while the professional classes were getting more and more depressed. Even in 1943, when the writer left, a ricksha coolie could earn more in a day than a University professor. Every credit is due to those teachers, professors, and research men who have remained at their posts in spite of these difficulties.

Education and research

These two subjects may conveniently be considered together, because Chinese universities and agricultural colleges combine research with advanced education to an outstanding degree, as has been shown by Dr. Joseph Needham's recent articles in *Nature*.[1]

Education is open to both sexes. It usually begins at the primary or elementary level, though there are Montessori or other infant schools in some of the cities. Elementary education can fairly be described as universal, but

[1] J. Needham, "Science in Chungking," and "Science in western Szechwan" (*Nature* 152 (1943) 64, 343, 372).

not compulsory. That is to say, there are numerous small elementary schools in remote country districts, often housed in old temples, as well as in the towns and cities. Nevertheless, there are many children, particularly those of poor parents in town or country, who do not attend school; and naturally in the early stages of a growing education scheme there are not enough qualified teachers.

Because learning Chinese characters by heart is a difficult and time-consuming process, even for Chinese children, the rate of education in the elementary schools seems rather slow, while the range of subjects covered and the breadth of their treatment is restricted. Geography, for example, receives little attention. On the other hand, there is much emphasis on the new nationalism of China, and on the struggle with Japan. Throughout the educational system, as well as in research stations, and government offices, a "Sun-Yat-sen memorial ceremony" is held on every Monday morning. At this, certain sayings based on his "Three principles of the people" are recited in unison, songs are sung, his portrait is bowed to, and an address or exhortation is given. Children trained in this mould from childhood will certainly have a definite trend given to their thoughts as adults, and this may be important in the post-war development and international reactions of China.

The next stage of education in China is there known as "middle school," equivalent to our secondary and public schools. Here, as is natural, education covers a much broader field than in the elementary schools; the sciences are prominent, in addition to Chinese literature and history; and one or more foreign languages, usually English, are taught. The emphasis on nationalism is still more intense, and middle school (male) students in general wear semi-military uniforms with peaked caps. The middle schools seem to have received the greatest degree of favour from the government during the war years, so that they have developed enormously; they are able to offer sufficiently high salaries to draw research workers away from research institutes, and even to attract staff from the universities.

It is from the middle schools that the great majority of young officials and elementary school teachers are recruited. The universities naturally contribute their quota, but their number of students is far from sufficient to meet the needs of the rapidly developing New China. Every city and large town or county (*hsien*) town has its middle school (more than one, of course, in the case of large cities), so that the brightest of the elementary school students can go on to the middle school without much difficulty, even if they live in quite a remote part of the province. There is also a limited number of "vocational schools," similar to our technical schools, which specialize in the teaching of industry or agriculture. Most of the middle and vocational schools are indigenous to Szechwan, although a few migrated to Szechwan like the universities when the Japanese advanced. One such is the Ming-hsien College, an agricultural school of high reputation which before the war was established at Taiku, Shansi.

The story of the universities in China is well known to the world. Rather than lose their independence under the Japanese they migrated great distances, often on foot and under appalling travelling conditions, in order to find a home in Free China. Often the students and staff arrived with little more

than the clothes they stood in, and perhaps a few boxes of books or precious equipment like microscopes. In west China the universities had to start again, frequently in makeshift buildings.

Many of these refugee universities came to Szechwan in the early months of the war, and most of them have remained there ever since. Chengtu in particular has become a university centre: before the war, the West China Union University (of mission origin) and the National Szechwan University were established there; during the war at least five other universities or university colleges have found a home there, notably on the hospitable campus of West China Union University. Among these the best known are possibly the University of Nanking, and Yenching University (from Peiping). There have naturally been problems of supplies, administration, and personnel due to crowding and other wartime difficulties, but on the whole the universities have worked remarkably well together, offering access to each others' classes, libraries, and laboratory facilities. The vitality of their intellectual life is most stimulating, and full of promise for the future. The pressure on the universities by prospective students has been immense. Where a few hundreds of places were available in an entrance examination, thousands of candidates applied.

The main lines of university education in Szechwan are similar to those abroad: there are courses in arts (particularly for intending teachers), in the pure sciences, and in applied sciences including engineering, aviation, and agriculture; certain universities also teach medicine and dentistry, and theology. One thing that strikes the foreigner is the lack of emphasis on law as a profession; there are few lawyers as yet in China, because the Chinese people are rather reluctant to go to law. On the other hand, the pure and applied sciences are greatly developed in Chinese universities, with an obvious eye to improving wartime and post-war industry and production.

Most science degrees are research degrees, even though the type of the research done is often severely handicapped by wartime limitations; and there is much post-graduate research as well, carried out by the junior or assistant staff under the direction of senior professors. Some of this research work gets out into the field, not only in agricultural but also in social subjects.

University research often links up with the investigations of the agricultural and other research institutes or bureaux, of which there are quite a number. In agriculture, Szechwan has its own Provincial Agricultural Improvement Institute, which was founded before the war but expanded greatly during the early war years; and this institution has sub-stations and sericulture (silkworm production) stations in at least seven localities widely dispersed through the province. The National Agricultural Research Bureau, which has branches in various provinces of Free China, has its headquarters and central laboratories near Chungking; and so do other National research institutions, including the Forestry and Animal Husbandry Bureaux, the Geological Survey (including the Soil Survey of China), and the Academia Sinica. All of these institutions have been carrying out valuable laboratory and field investigations during the war years, in spite of the enormous difficulties, and they have made real contributions to wartime production as well as laying secure foundations for post-war development. (Some of their work is

reviewed by Needham in *Nature* (*loc. cit.*), and also by the writer in an article published in Chungking.[1])

Some agricultural improvement work had been done in Szechwan before the war, notably by Professor Frank Dickinson, of West China Union University, who had for fifteen years or more been introducing improved varieties of crops, fruit trees, poultry, and livestock to Chengtu. The results of his work were visible in many ways during the war: dairy farmers had cross-bred milking cows with a milk production several times greater than that of the local "yellow cow"; there were orchards of apples, lemons, and other fruits that had not been known in the province before—these fruits reached high levels of production, and were shipped to Chungking for the use of Government officials and others there. During the war, when the University of Nanking College of Agriculture, and other universities and research stations, took part in similar work, crop and animal improvement went forward at an accelerated rate in many parts of the province: even artificial insemination was successfully introduced to make better use of the few pedigree animals available; there can be no doubt that this agricultural improvement work was a substantial factor in increasing the food supplies of the province, and so in strengthening China's resistance.

This modern and up-to-date agricultural work, carried out against the rather primitive background of rural Szechwan, often presented curious contrasts. Many agricultural research stations, for example, have walled compounds and guards with fixed bayonets at their gates day and night; complex field experiments might be laid out in fields where it was dangerous to venture late at night because of bandits; research workers have been robbed in daylight when travelling to outlying stations. One university was taking a large part in an "experimental *hsien*" where social and agricultural surveys were carried out, and attempts at improving the lot of the farmers were under way. The experiment was broken up, and one of the university staff was killed, when a riot took place, started it is said by the "Red Lantern Society"—a Boxer group opposed to any kind of modernization. There was also a suggestion that local landlords were disturbed by the results of the accurate land surveys carried out by the university staff. There was found to be more land in the *hsien* than was paying taxes.

Here, as in other matters, the persistence and perseverence of the Chinese character asserted itself. This experimental *hsien* broke down: but another was established in a different locality, and it has already a fine record of survey work and social improvement. Field experiments on crops, located in a region where a mild famine occurred, were pillaged of their grain when ripe by starving country people: but other experiments were carried out elsewhere, and continued to be carried out, giving valuable results.

The Central Government, under Generalissimo Chiang Kai-shek, has prepared elaborate and ambitious plans for the post-war reconstruction of China, which are described in 'China's destiny,'[2] a book that deserves serious perusal

[1] H. L. Richardson, "Wartime research on the earth and its products," in 'Wartime China as seen by Westerners.' Chungking, 1942, pp. 173–88.

[2] Published in Chinese in 1942. A short summary was given in *The West China Missionary News* for January–April 1943.

by all who are interested in world affairs. It is to be hoped that a translation will soon be published. Szechwan, with its productivity, large population, and great natural resources, especially in coal, water power, heavy chemicals, and potential production of fertilizers, will play a large part in this programme, and rapid post-war development may be expected as a result of the education and research work that has been carried out during the years of the war.

Anything that Britain can do now, to train Chinese engineers, agriculturalists, and other technical men so that they can return and take part in post-war reconstruction, will be well worth doing. Advice and assistance will be needed in the development of industrial undertakings under Chinese management, though the field for independent industries under western management may be restricted. It will be found that there is considerable interest by other nations, particularly the U.S.A., in the post-war reconstruction of Szechwan as well as other parts of China, but this need not exclude British experts if they have special technical or scientific knowledge to contribute.

Note on construction of the map

The accompanying map is based on the atlas of 'New maps of the provinces of China,' published by the Shun Pao Press (Shanghai, 4th ed. 1940). In the western Szechwan and Sikang borderlands additions and corrections have been made from Dr. Richardson's surveys, and from the map which accompanies André Guibaut's paper "Exploration in the Upper Tung Basin, Chinese–Tibetan borderland" (*Geogr. Rev.* 34 (1944) 388). The geographical positions in this area are from Cartographic Records No. 1, by S. Y. Tseng. (National Geological Survey of China, Pehpei, Chungking, July 1943.)

DISCUSSION

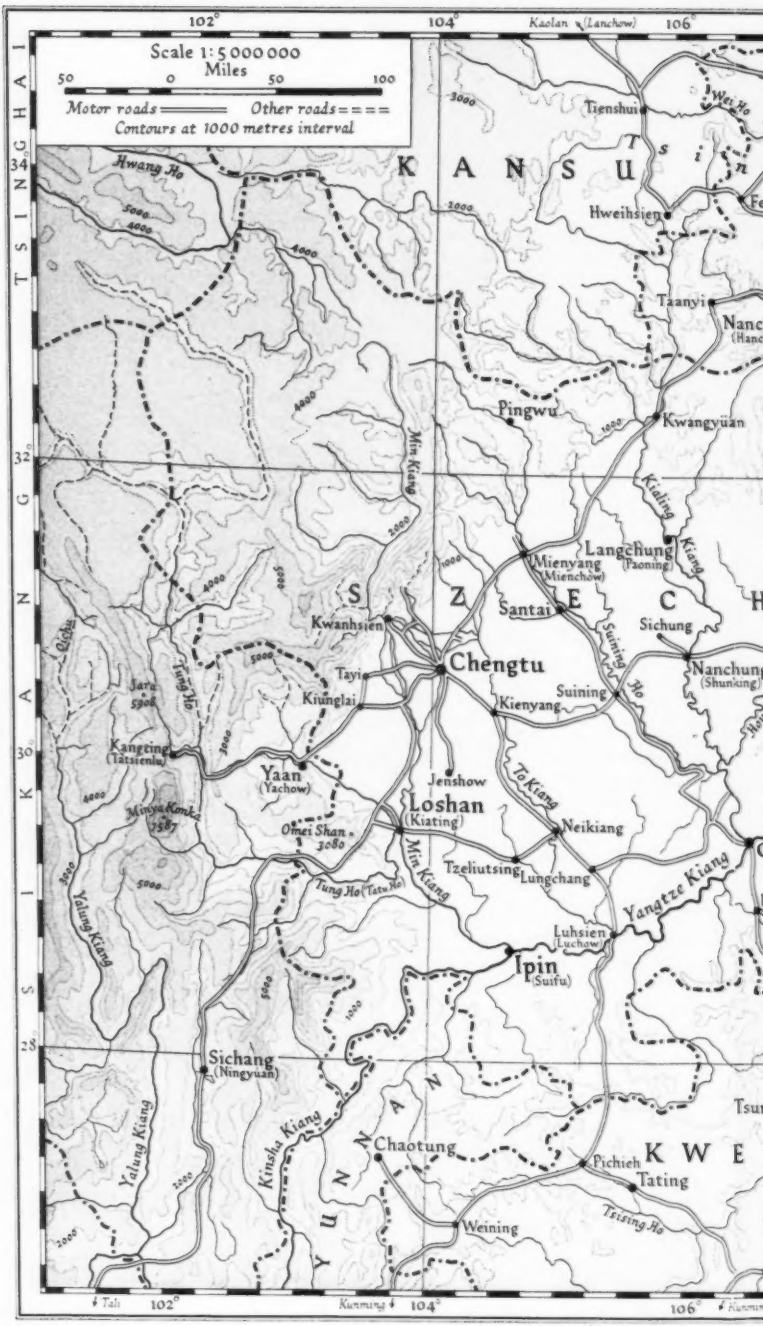
Before the paper the PRESIDENT (The Rt. Hon. Sir GEORGE CLERK) said: Our lecturer this evening, Dr. H. L. Richardson, of the Rothamsted Experimental Station, returned in 1943 from Western China, where he had spent six years as adviser to the Agricultural Research Bureau of the Ministry of Agriculture. His work took him on many journeys through Western China, and into contact with all classes, but naturally his closest associations were with the farmers. To-night he will deal with Szechwan, the province which has played so important a part in the national resistance to the Japanese. He will tell us of the country and its people, agriculture, and industry, and of the changes which war has brought. After his paper we hope to hear from Mrs. Richardson something of family life in Szechwan.

Dr. Richardson then read the paper printed above, and a discussion followed.

The PRESIDENT: I will ask Mrs. Richardson to supplement the very interesting lecture we have just heard from her husband.

Mrs. RICHARDSON: The modern movement has made many changes in Chinese life, and nowhere more than among the women. Forty years ago, Chinese women above the coolie class did not go out into the street except in closed sedan chairs, and the sight of a respectable woman doing a little shopping was so rare that it was apt to collect a crowd, and might start a riot. Elderly missionaries have told me that in their early days in China they were accus-

Map to accompany the paper SZECHWAN DU



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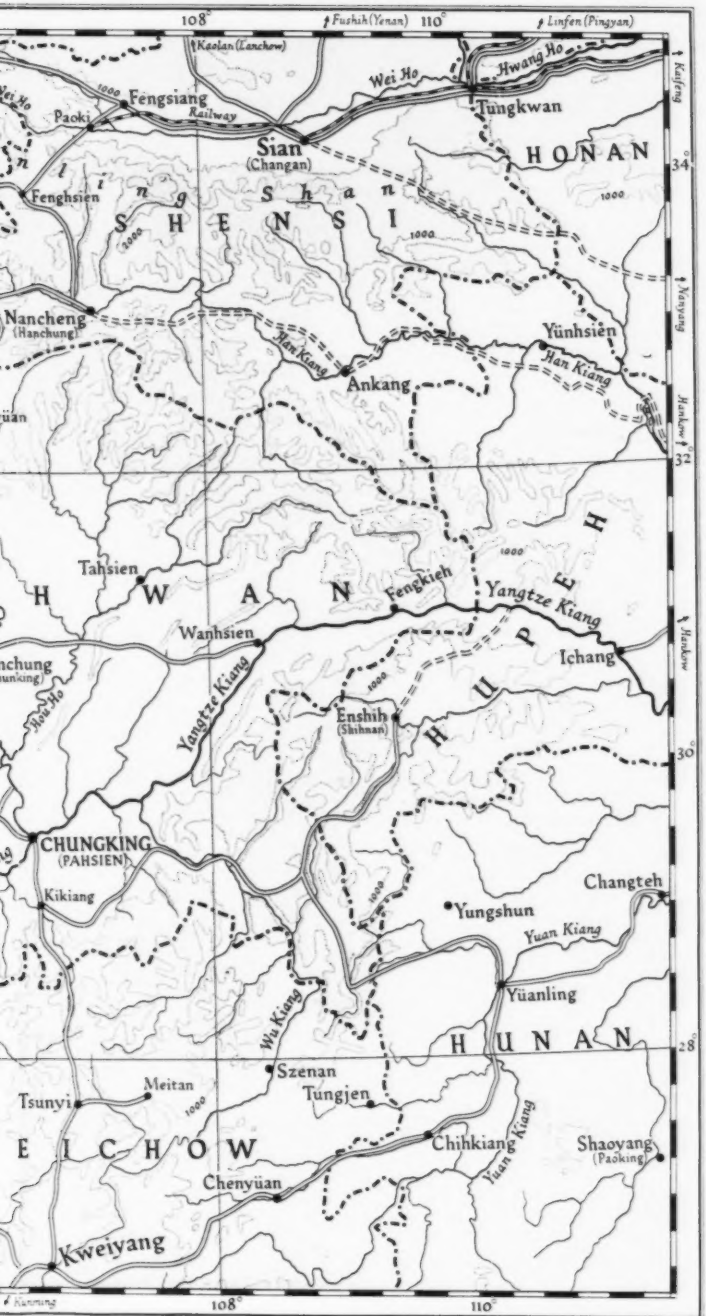
DURING THE WAR by H.L. Richardson



al Geographical Society

SZECHWAN
Richardson

tomed to wear men's clothing, with a false queue pinned inside the hat, in order to avoid such unplesant attentions. But now all that is changed. It is a tribute to the character of Chinese women that this great change has taken place so rapidly, and so smoothly.

When I first reached China, I set myself to learn the language, in order that I should not be confined only to the society of women who had had an European education. I soon found the magnitude of the task I had undertaken, but persevered, and at the end of two or three years I could chatter fairly easily about domestic topics, of course in the local dialect. My work was well rewarded, and I was able to make some very pleasant acquaintances in varied social classes, so I learnt something about Chinese family life not only among professional people of modern education but also among farmers and merchants.

Of course, I did not get to know any of the real old, strict, Confucianist families, for their disapproval of practically everything certainly includes Europeans. Many such families undoubtedly still exist, hidden away behind the high grey walls of quiet streets and lanes. They carry on the old life almost as if the new things were non-existent.

But even the most conservative must bow a little to the new things. In Szechwan, many of the changes have only come about since the war. The "new women," refugees from east China, were surprised and shocked when they found that conditions in the west were much like those that their mothers had described to them. The Szechwanese were also apt to be shocked. As one nice old lady said to me: "These modern young women will try to ape the men. Instead of wearing trousers as a decent woman should, and smoking a water pipe, they wear long-skirted gowns like a man, and smoke cigarettes."

But the shock did not last for long. The Szechwanese ladies looked, gasped, and then copied. Instead of the everlasting blue trousers and little black jackets, with hair done into a tight bun behind, they began to wear bright-printed cotton gowns, and the most exotic hair dressings. They heard with envy of the conveniences of life in Nanking and Shanghai, and they began to wish for more modern homes that would be easier to keep clean.

The Chinese like to live in the "joint family" system. When a man marries, he does not leave home, but brings his wife to it. Here they live with the husband's parents, with brothers' wives and families, with uncles and cousins and grandparents and aunts, sometimes to the number of a hundred persons and more. Very large households are only possible among the rich, so that they have become almost a symbol of wealth, much more so than a motor car or an expensive gown.

The old style house is built around courtyards, and is easily added to as the family increases in size. A new wing is thrown out, a new courtyard enclosed, and room is found for several more newly married members. The construction is very simple: windows are of lattice covered with paper; there are seldom any ceilings, and overhead the under sides of the roofing tiles can be seen. The floors are of pounded earth or, in wealthy households, of rough, unscrubbed, boards. Dust and flies are thick, unless many servants are employed, and the chimneyless kitchens are always reeking of smoke and soot. It is not that the people are dirty from choice, but simply that their ancient method of house construction involves the most appalling amount of labour in being otherwise.

Chengtu has a University built in excellent taste, with a charming compromise that includes the curling roofs of Chinese architecture, and the stout brick walls with many windows that come from abroad. With this good example before them, the new houses being built there seem to be avoiding the standardized ugliness of so much of the new housing in the west.

Housekeeping and child-welfare will probably always be the chief interest of the women. But individual women will often have other interests, just as men do. So one meets women in China succeeding at all sorts of unexpected jobs. One woman, whose husband was away at the war, was carrying on his business as a tinsmith. Others are more interested in science. Among my women friends were a professor or two and several research workers, and they were doing good work. Women who are capable of running a big joint-family household, with perhaps a hundred members, and half as many again as servants, must of necessity be good organizers. It is not surprising to find them now, running a factory for a cooperative society, or organizing welfare work, or directing an orphanage.

As in western countries, teaching seems naturally to be a woman's profession; any plans for educating a population of four hundred million must naturally require an enormous number of teachers, and China will have to draw very heavily on her women to staff the ever-increasing number of schools. Indeed it is probably true to say that until enough women are educated to staff them, it will be quite impossible to open enough schools to touch more than the fringe of the problem. The services of every educated Chinese will still be far from enough to carry out the great new plans foreshadowed for the future.

The PRESIDENT: We are fortunate to have with us to-night Dr. George Yeh of the Chinese Ministry of Information; perhaps he would make a few comments.

Dr. GEORGE K. C. YEH: I should like to express my personal appreciation of the very instructive lecture we have just heard and the intimate picture Mrs. Richardson has presented of the people in Szechwan. If I had anything to contribute it would be to support and substantiate everything which Dr. Richardson has said. I have lived for a good many years of my life in Treaty ports such as Shanghai, Tientsin, and Nanking, where the Chinese enjoyed and became accustomed to the ready-made comforts provided by the Europeans. They were in fact enjoying these comforts so much that they almost mistook the coast of China for China itself. It was not until the war had driven all of us into the interior, to Szechwan, Yunnan, and other inland provinces, that we realized that there was another China, a China much more indigenous than the one in which we had been brought up. The war brought about not only a national resistance but also a rediscovery of China by the coastal Chinese themselves.

I think the effect of this will probably be greater than any political changes which may take place after the war in China. Perhaps I should not have said this in my official capacity, but as an academic man I believe that in the long run it is the changes in institutions that really matter to us.

I am very pleased to have been invited by the President to come to this meeting and to have heard such an excellent exposition of the life in Szechwan. Szechwan was once more or less to us—and I am referring here to the small number of sophisticated coastal Chinese who really do not matter as much as the Chinese in the interior who form the backbone of China's resistance—like a colonial part of the Chinese Republic. I remember when I first visited Chengtu and Chungking in 1931 I was struck only by the backward conditions of life in Szechwan. I found that there was a difference of twenty-five to forty years in material conveniences between the coastal cities and the interior, but I did notice then that the province was, indeed, unique in many ways, in its agriculture, in the native intelligence of the people, in its old irrigation systems, and in its retention of many features of Chinese life already lost on the coast. The Szechwan people are known for their craftiness in business and for their assertiveness in public. But they are never small-minded. That perhaps is due

to their local geography. As one of our very early geographers put it, it is the character of the hills and lakes of a province that produce its famous people. The ancient Chinese believed that geography produced the man. A famous story is told of two state councillors who were at loggerheads for many years, and when they both retired they advised each other to go to a province where they would view higher mountains and broader rivers than they had been accustomed to, inferring that they had both been small-minded.

I hope that this society will provide more lectures of the type we have just had the pleasure of hearing, which I am sure can do more to bring the people in this country closer to people of other lands than any propaganda.

Mr. W. V. BLEWETT: I am horrified at the idea of my putting a finishing touch to the excellent lecture we have heard because I am not capable of any such thing. I was in Szechwan during part of the time when Dr. and Mrs. Richardson were there. I met them there and I can certainly corroborate what Dr. Richardson said, though as I did not see much of the Chinese ladies I cannot corroborate what Mrs. Richardson has said. I speak very little Chinese and unless one does speak the language it is difficult to know China; but I saw a good deal of Szechwan and was struck by its great beauty as an agricultural area.

When I went to Chungking in 1942 after some years of absence from China I found it rather grim. I had travelled widely in China before, north, south, east, and west, but not Szechwan, and Chungking seemed decidedly drab. I lived in the two foreign style hotels and there was little difficulty over food. Some things were rare, such as butter and milk, and I remember if I wanted to give a lady a treat I took her to the only dairy in the town and gave her a glass of milk which cost, with mine, fifteen shillings.

I would like to pay my tribute to the Chinese farmer. It has been my job to meet the farmer in many countries, and I met a large number in China, and would like to express my appreciation of the simple, homely, intelligent and friendly attitude of the farmers. The Chinese farmer is very largely China.

The PRESIDENT: We have had a very delightful and instructive evening. I wonder if something that occurred to me occurred to anybody in the audience about the situation of Szechwan faced with the cataclysm of its normal life. Substitute for the mountains round Szechwan the narrow seas and the Atlantic round our country and look upon the rest of China as Europe, and you will see that it is very like the position of this country when it was menaced by the hordes of Hitler, and in the same way the same simple virtues of life based on the tradition of the country have helped them to hold out and to carry on and will help them to carry on through the trials which still await them.

That however is by the way. What I do want to do on your behalf is to thank Dr. and Mrs. Richardson for giving us this very excellent lecture and to thank Dr. Yeh and Mr. Blewett for their interesting comments upon it.

DUST-STORMS IN EGYPT AND THEIR RELATION TO THE WAR PERIOD, AS NOTED IN MARYUT, 1939–45

F. W. OLIVER

THIS PAPER deals with the general phenomena involved in desert dust-storms as illustrated by their incidence at Burg el 'Arab in the Western Desert of Egypt during the six-year period October 1939–September 1945. Throughout this period the desert surface was subject to a sequence of mechanical disturbances incidental to military operations which culminated in the Battle of El 'Alamein (October–November 1942); thereafter a period of relative quiescence ensued.

It happened that I was able to remain in the village throughout the entire period, and as the record is probably unique and unlikely to recur, it seems worth while to make accessible some account of the occasions and general circumstances of dust-storm incidence as they came under my notice.[1] Though no meteorologist, I have some familiarity with one important factor in dust control, the vegetation covering, a circumstance which may in some degree offset inevitable deficiencies in meteorological technique. This paper, then, is substantially a record of observations on dust-storms, with some commentary, confined practically to the visible horizon of Burg.

Burg is about 30 miles west of Alexandria, and roughly half-way to El 'Alamein; it is 3½ miles inland from the Mediterranean shore-line, thus being on the coastal zone of Egypt which derives a moderate, if irregular, winter rainfall from its proximity to the sea. This favoured zone, for want of a better term, is called "semi-desert": it extends inland some 10–15 miles.

The elements of our subject-matter are briefly the loose dust which encumbers the desert surface ("dust-reservoir"), and its relation to winds and other factors affecting its mobility.

Local topography

Before passing to the real subject-matter of this article, something may be said concerning the terrain round our station at Burg, followed by brief notes on wind and weather conditions.

Our point of observation (Burg) stands on a low mound overlooking to the south nearly level ground rising gently to the desert plateau, which reaches a height of 200 feet some 4 miles due south (*cf.* Map, p. 29, and Plate 1). To the north of Burg, ½ mile distant, is an inner coastwise ridge followed by an outer parallel ridge 2 miles farther north. This latter overlooks the sea, distant less than 1 mile, from which it is separated by white oolitic limestone dunes. Between these two coastwise ridges is a flat valley occupied by the bed of Lake Mareotis (*i.e.* its western arm)—the level being approximately that of sea-level.

[1] An earlier paper covering the years 1940–41 appeared in January 1942. That issue, printed by Messrs. Whitehead and Morris, Alexandria, is now out of print. However all essential facts relating to this earlier period are embodied in the present paper.

This plain normally carries a close salt marsh vegetation, and, as the sequel will show, has become a contributing element in the local dust-storm production (*cf.* p. 32).

Compared with the rugged landscapes of the Eastern Desert of Egypt the Western Desert is relatively unspectacular. The wadis are not deep-cut precipitous trenches, nor is the general surface thrown into high relief. It is a gentle desert landscape which strangers at first incline to term featureless (Plate 1). The two coastal ridges reach a height of about 120 feet. The outer one alone, at a point 1½ miles north-east of Abu Sir, carries a knob, Kom el Nugus, 170 feet high.[1] This summit shows a quadrangular depression which was occupied in ancient times by a guard or outpost: traces of barrack buildings still remain. From this point the entire countryside is visible.

The accompanying sketch-map summarizes the essentials of the topography and present-day communications. The coast or "treaty" road runs in the trough between the outer ridge and the dunes. Abu Sir is the main archaeological centre with its temple and Arabs' Tower as landmarks.[2] Close by, the Burg by-road joins the coast road, after crossing the two ridges and intervening lake-bed. This by-road, as it crosses the outer ridge, follows closely the site of the old Barbarians' Wall which stretches from the lake bed to the dunes. Beyond the dunes is the sea. Presumably this wall was designed to exclude the rougher Libyan element, and may have been correlated with a garrison at Kom el Nugus, with the Arabs' Tower as a signal station.

In those Ptolemaic days Maryut was highly cultivated. Abu Sir must have been a frivolous resort for Alexandrines at pleasant seasons, with flowers or fruit, music, and boating on the lake—all with gentle pastel desert landscapes, the dazzling dunes, and deep blue, iridescent sea. Approach from Alexandria was by boat on Lake Mareotis—not possible to-day. To the south of Abu Sir jetties and harbour works still remain. From this harbour a canal had been driven to the north side of the ridge (Gebel Maryut) opposite the present Burg el 'Arab, where an ancient dock is recognizable. This was probably employed for water transport of country produce from south to north. The ground dug in making this canal was heaped on its west bank and served as a dry causeway across the lake bed. The lakeside harbour at Abu Sir was controlled by lock-gates at its western end. Beyond the lock (west) the lake bed was canalized, certainly to a point north of Gharbaniyat and probably beyond into the Hammam sector.

Wind and weather

The prevalent wind here is from the north-west sector and to its moderating influence is due the mildness of the summer temperatures compared with interior Egypt. The main departures from a state of calm are occasioned by

[1] Till lately wrongly identified with the ancient town of Plinthine; *cf.* John Ball, 'Egypt in the classical geographers,' Cairo, 1942, p. 65. Footnote by Mr. G. W. Murray. (*Note:* on the Survey of Egypt 1/100,000 sheet, Kom el Nugus is shown 3 miles to the north-east of Burg el 'Arab. In the sketch-map accompanying this paper we have shown it in the position given by the author.—ED. *G.J.*)

[2] Plate 2, from the lake bed, looking north, shows on the skyline the Temple (lef centre), and the Arabs' Tower (right). Kom el Nugus is farther to the right, off the picture.

depressions travelling west to east, far out in the Mediterranean. These are accompanied in northern Egypt by south-east and south winds, especially in the period January to May. These passing depressions attract a flow of air from Egypt—hence these winds, which are known as Khamsin: with deep depressions, these winds blow with great violence. In sweeping the desert to the south, they have a double action. Being hot and dry, with relative humidities of 30, 20, even 10 per cent., the mantle of dust is fully dried out so that the grains lose all coherence, and in this desiccated state are raised freely into the air and carried along as dust-clouds.

A normal procedure is for a south-east breeze to spring up soon after sunrise, and as this gains a velocity exceeding 12 miles per hour, a slight opacity becomes apparent, which as the wind strengthens will, say by 9 a.m., have intensified so that visibility is cut down to such distances as 400, 200, or 50 metres. Such obscurity may continue for four or five hours. Meanwhile the wind veers to south and then, often suddenly, through south-west to west and north-west. Average wind velocities on these occasions are of the order of 20–30 miles per hour, sometimes more. As the wind reaches the north-west sector, it is no longer blowing mainly off the desert, but from the sea. This is accompanied by a marked fall in temperature. In its southerly phase the Khamsin brings temperatures approaching 40° C. (104° F.), but when it veers to the north-west there is rapid cooling and within fifteen minutes the temperature reading may drop to 27° C. (80·6° F.). These hot winds characterize the later months (April–May): earlier in the year a Khamsin may be relatively cold. But even after the wind has veered north-west the dust-storm will continue till the velocity abates. Formerly there was little loose dust to be swept up between Burg el 'Arab and the coast, but since continuous disturbances of surface through military operations came with the war the conditions have been altered, and an abundance of loose dust developed on the lake bed, as well as elsewhere.

Sand and dust

It is necessary to distinguish clearly between sand and dust, sand-storms and dust-storms. While the unit particles composing sand and dust are akin and belong to the same order of matter, their behaviour under wind is entirely different. Sand lifted from the ground proceeds down-wind in a series of low hops or saltations, and as the grains under the pull of gravitation once more strike the ground they will either bounce into the air, or hitting another grain at rest, will flick it off the ground. The drift of sand is thus a cooperative or community effect. This explains why sand remains aggregated in dunes. In practice, sand advancing in a wind is restricted to a sort of creeping carpet extending upwards not more than 2 or 3 feet from ground-level—from which carpet the greater part of an erect human figure will project, except in the most violent storms.

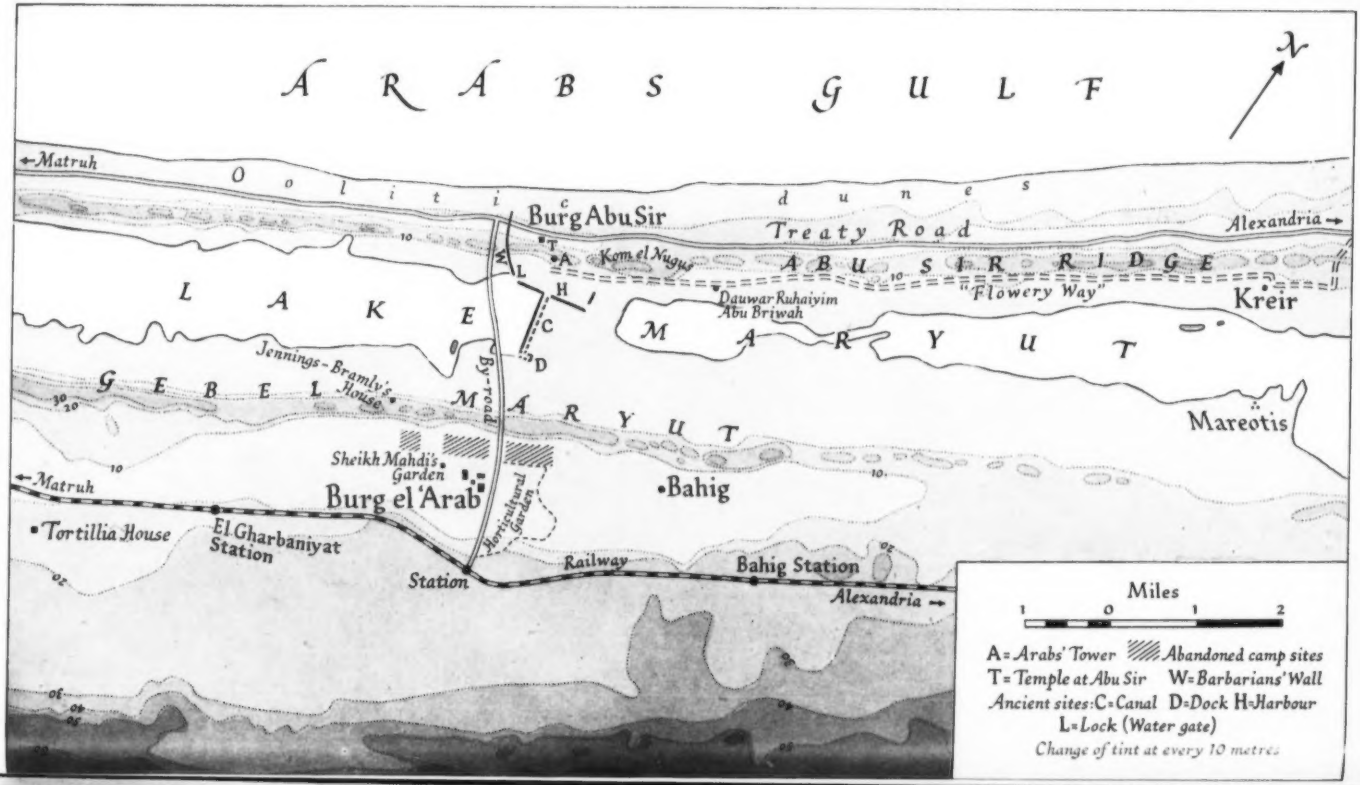
This whole subject of sand-movement has been elucidated by Brigadier R. A. Bagnold in his recent book,[1] a contribution combining the results of field observation in the Libyan and Saharan deserts, on the one hand, and of intensive experimental studies under controlled conditions in a physical

[1] R. A. Bagnold, 'The physics of blown sand and desert dunes,' Methuen, 1941.

1. Desert south of inner ridge: Burg el 'Arab left, Sheikh Mahdi's garden right

2. Bed of lake Maryut looking north, pre-war state of marsh scrub. On skyline temple at Abu Sir and Arabs' Tower

3. 'Seil' or storm-water forming temporary lake, Burg el 'Arab, 13 Jan. 1937


ARABS GULF
N
Matruh
Oolitic dunes
Burg Abu Sir
Treaty Road
Alexandria
Kom el Nugus
ABU SIR RIDGE
"Flowery Way"
Dauwar Ruhaiyim
Abu Briwah
Kreir
LAKE
MARYUT
Jennings-Bramly's House
By-road
GEBEL
MARYUT
Mareotis
Sheikh Mahdi's Garden
Matruh
Burg el 'Arab
Bahig
Horticultural Garden
Tortillia House
El Gharbaniyat Station
Railway
Bahig Station
Station
Alexandria
Miles
1 0 1 2
A=Arabs' Tower
Abandoned camp sites
T=Temple at Abu Sir
W=Barbarians' Wall
Ancient sites: C=Canal D=Dock H=Harbour
L=Lock (Water gate)
Change of tint at every 10 metres

laboratory (including a wind-tunnel), on the other. This book marks a definite epoch in the knowledge of mobile sand.

Dust, in contradistinction to sand, consists of the smaller, lighter particles, and is incapable of these saltatory and flicking activities. Once raised from the ground dust particles, owing to their lightness, are liable to become the toy of upward or other irregular currents in the air, where they remain in suspension till such time as air-movement moderates. Dust travels in clouds, often at height, and is liable to dispersal over great distances. Certain local uni-directional winds are especially effective in this dispersal. Thus there is the Harmattan which carries dust south into Nigeria and beyond from the Western Sahara; the Haboob in the Sudan; and the Khamsin winds of Egypt and North Africa, which coming from the south-east and south, carry the Libyan dust over the Mediterranean. On particular occasions (*e.g.* March 1901) such dust has been recorded as streaking across Europe from the Sahara as far north as Sweden.[1]

Dimensions of particles.—Bagnold draws the lower size-limit of particles behaving as sand, *i.e.* characterized by bouncing and flicking, at about 0·08 millimetre. Below that comes dust which floats in the air and is subject to aerial dispersal. All my own measurements of dust falling in still air conform to Bagnold's generalization. I find dust from the Libyan Desert to range in diameter of particles from about 0·07 millimetre to mere specks of 0·002 millimetre ($=2\mu$). Dune sand ranges upward, according to Bagnold, from 0·08 millimetre to anything raisable by wind, *i.e.* up to 1 millimetre or more. In the Libyan sand used in his wind-tunnel experiments, the predominant element was about 0·3 millimetre in diameter, to which East Anglian sand dunes closely approximate. On the other hand, the sand of the Comporta dune facing the Atlantic, south of the river Sado in Portugal, is much coarser, 75 per cent. by weight of the grains falling between 0·5 and 1 millimetre.

The fate of dust is dispersal, and, under particular conditions, a consider-able proportion of it must fall into the sea and ultimately find its way to the ocean floor. Sand however, whether it be blown into the sea from coastal dunes, or, water-carried, be discharged from the mouths of rivers, will in either case sink not far from the edge of the land, *i.e.* in shallow water. Unlike dust it will not be lost in ocean depths, but by the action of waves and tides in these shallow waters will be thrown back on the shore, whence suitable winds will return it to the land. Thus even in these later stages of their travel, dust and sand behave consistently: dust tends towards dispersal and ultimate fixation; sand from its "gregarious" quality, tends to remain in, or return to, the sphere of its activation.

Deflation.—This lifting and transporting power of wind by which small detached particles of the erosion-litter are removed has long been known as deflation—a general term covering all forms of wind removal. It will be evident that the mechanics of deflation differ according to the grade-size of the particles. In this article we are concerned with the finer grades (dust) which feed the dust-storms of the Libyan Desert. In this connection it was susceptible land in North America (The Great Plains) which led to the term "dust-bowl." There it was agricultural land that was being destroyed through

[1] *Cf.* J. Walther, 'Das Gesetz der Wüstenbildung,' 2nd ed., 1912, p. 65—map.

improper management; in Egypt the dust-bowl relates to desert land, agriculturally unimportant to-day. Nevertheless, two thousand years ago, the northern coastal strip was famous for its cultivations and enjoyed a high degree of fertility. But we are not concerned here with the full story of erosion and the decadence of agricultural lands involved. For this, reference should be made to two handbooks recently issued, viz. Jacks and Whyte, 'The rape of the earth' (Faber, 1939) and H. H. Bennett, 'Soil conservation' (McGraw-Hill, New York, 1939)—both are authoritative and written with full knowledge.

Accumulations of dust.—Should a casual visitor arriving in this district in calm weather desire to examine evidence of dust-storm incidence, he should search out depots of accumulation. These occur especially to windward of unobstructed vertical surfaces facing directions from which dust is driven. Garden walls are especially useful in this connection, being less liable to interference than houses or other occupied buildings. Such walls should be free from obstruction by other erections, trees and the like, and must face directly open desert.

Two examples from this neighbourhood are illustrated in plates 4 and 5. The latter represents the west-facing wall of Sheikh Mahdi's olive garden, 750 yards due west of the western gateway of Burg; plate 4 is from the north-west boundary wall of the garden of the Tortillia House at Gharbaniyat (3 miles south-west of Burg). These banks accumulated in a few months during the period of maximum dust-storm incidence. The Sheikh Mahdi picture was taken in April 1942; the Tortillia one in July 1943. Sheikh Mahdi's wall is 5 feet high, and there are several points where dust has piled up to the wall-top (as in the foreground where Beduins are filling sacks with dust for experimental purposes). At such points bridge-heads arise where dust drifts across and advances over the garden. The wall here runs due south to north and the bank on which the figures are standing is the west-facing bank of dust reception. The Tortillia wall (Plate 4) is 9 feet high (or more) and faces north-west. The wind had built up a spectacular "vallum" or rampart all along this side of the property. The dust intercepted to form these outworks obviously travelled low, and would be derived from low drifting dust driven before horizontal winds or from the lowest stratum of more extensive clouds.

Raising of dust.—It is no part of my intention to consider the source of dust on this desert. Obviously it is a chief product of erosion, and in amount must be greatly in excess of sand, which is definitely localized. In this district the ground consists mainly of a fine colloidal clay with rock reaching the surface at many points. Before the war, when all roads were unsurfaced (dirt tracks), if heavy rain saturated the ground all mechanized traffic was immobilized.

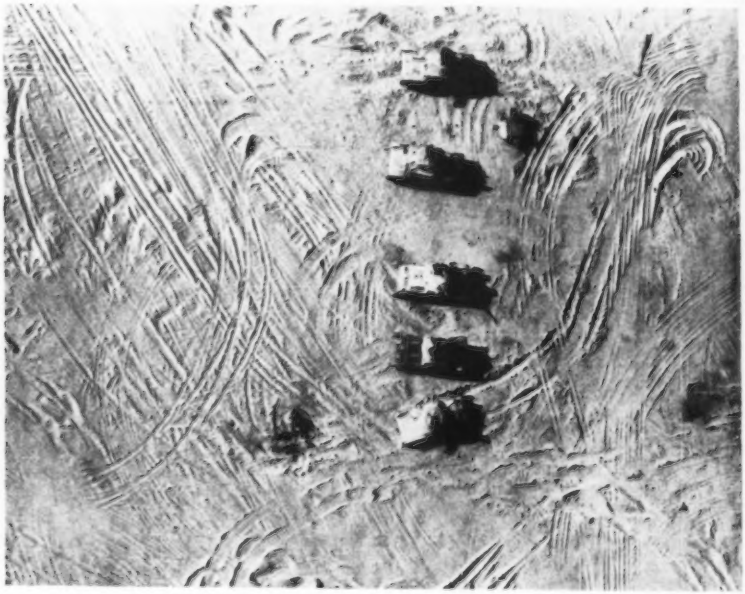
Bagnold, whose studies were mainly on the transport of dune sand, makes occasional reference to dust.[1] He sees in these surface-sheets a mantle relatively immobile under wind, and when grains of sand or grit are blown over it they sink into this soft matrix (or "quagmire") and go out of action. He stresses the part played by animals, human beings, and traffic as efficient raisers of dust. That is undeniable. Nevertheless, I have seen sheets of dust raised by wind, especially high-powered, gusty, turbulent winds.

[1] R. A. Bagnold, 'Physics,' etc., pp. 6, 90.

4. Dust banked against boundary wall, Tortillia property, July 1943

5. Collecting dust from Sheikh Mahdi's garden wall, 4 April 1942

6. Dispersed camp, east of Burg el 'Arab



7. Air photograph showing tanks and tank tracks

Even on relatively calm days localized vortices or wind-eddies, called "dust-devils," may be seen here and there streaking across country. These vortices are funnel-shaped and stand on their points, sucking up the dust. Even with a small one, where the funnel may be only 10–20 feet high, it is perfectly evident that the air in contact with the ground is revolving at high velocity. I have tried to obtain readings with a portable anemometer, but the "devils" would never stay "put" long enough.[1]

But there are further alternatives. Much light litter drifts over the desert surface in a wind. This litter is largely vegetable in origin and includes tiny plant fragments, bits of fruit valves (derived especially from annual Cruciferae and Leguminosae), seeds, quantities of grass spikelets, and so forth. With them are certain elements of animal origin, feathers, the dried skins of small caterpillars, fragments of beetles, and especially much fine comminuted snail-shell (*Helix desertorum*). There is a vast population of these snails in our district; they may be seen adhering in their hundreds to bushes, especially to asphodels. In the aggregate this drift as it scours the surface must contribute substantially to the dust-lifting agencies.

In dust accumulations, whether in front of obstacles in the open, or falling from the air in a room, there is always to be found, by screening, a small percentage of this organic drift. Naturally, from dust precipitating indoors it is only the finer, more buoyant elements that will be recovered. By weight this humus fraction is trifling—0·25 to 0·5 per cent. when separated from the dust.

Military operations and the dust-reservoir

Before turning to the records and any analysis or commentary, it is convenient here to refer to the various circumstances directly and indirectly connected with military operations in the Western Desert in their relation to the dust-storm position.

Before the war, three or four dust-storms a year would be a usual number, while the first year of the war (vegetation year 1939–40) shows a slight increase to eight. By 1940–41 the number had risen to forty, and by 1941–42 to fifty-one (Table 1). Considered here are the various operations, direct and indirect, which contributed to the increase in the potential reservoir.

It will be realized that from the first Burg el 'Arab had been marked out as a key-point for the assembly of forces in anticipation of eventual hostilities, and that as early as the winter of 1939–40 our horizon was already in process of becoming a vast armed camp.[2] This depended on the fact that 'Alamein, to the west, marked the line to be held at all costs. 'Alamein in a military sense is a "defile," roughly 40 miles wide: it is closed to the north by the sea, and to the south by the Qattara Depression—ground unsuited to military operations. Even as far back as the days of Rameses II, more than three thousand years ago,[3] there had been a battle of 'Alamein, followed by others in the reign of his

[1] Recorded in *Whitaker's Almanack*, 1938, p. 1041, are certain observations on "dust-devils" made in the Middle East (source not stated). More successful than I, records of the linear speed of rotation at the outer edge were obtained. These ranged from 10 to 40 miles per hour.

[2] *Cf.* plate 6, showing a portion of a dispersed camp, taken December 1939.

[3] J. Y. Brinton, "Some recent discoveries at el 'Alamein," *Bull. Soc. Roy. Archéol d'Alexandrie*, No. 35, 1942.

son Merenptah. 'Alamein is thus classic ground. Active disturbance became really effective following the Italian declaration in June 1940. This disturbance arose from two distinct causes, Beduin migration and military measures.

Beduin migration has been intermittent throughout, and is related to the military situation from time to time. In the earlier period, when operations became inevitable, large numbers of Beduin evacuated their usual camping grounds farther west, *i.e.* from the more exposed regions towards the Italian frontier. They straggled east into the zone, camping and grazing their herds, and cutting and pulling the scrub for fuel. Less disciplined than the normal resident population, who exercise some degree of responsible restraint in this matter, large areas became bared of scrub. It was also at this juncture that the bed of Lake Maryut was largely stripped,[1] an operation completed later by certain units of our own forces, who camped on the same ground. Then, in 1942, when our armies withdrew into the 'Alamein sector, there was a further general evacuation of nearly all Beduin of the Western Desert back to the Delta (Beheira). Following the battle of 'Alamein and the British advance into Cyrenaica and Tripoli in the late autumn of 1942, the Beduin were readmitted and straggled back once more. Even as late as the spring of 1944, due to unforeseen temporary causes, there was a further short evacuation east of Beduin from the Hammam–Burg el 'Arab sector.

In the aggregate these successive marchings and counter-marchings were responsible for much abnormal scrub-clearance, *i.e.* removal of perennial surface-cover (fuel and grazing). The most important element in this scrub is the bush *Thymelaea hirsuta*, which takes about five years to re-establish from seed. Being highly inflammable from its oily secretion this plant is much esteemed as fuel. Moreover, during the early stages of establishment the young plants are especially vulnerable to grazing animals; at one bite a goat will destroy a whole plant.[2] Military operations contribute excessive disturbance of surface with increase of reserves of loose dust. These include the breaking of surface incidental to the siting of camps, trenches, and fortifications in general (Plate 6); the laying of mine-fields, the making of roadways (chiefly non-metalled), and airfields—without runways in this district.

These are the preparatory measures. Next follows the traffic—lorries, tanks, and guns—mainly over non-metalled desert surfaces. This traffic by pulverizing the surface is unquestionably most important in the present relation. Where, for instance, lorries run between two points: at first they go direct; then as the surface becomes worn down and deteriorated to a depth of 6 or 8 inches, the drivers will choose unbroken ground alongside, till ultimately the original points are joined by an ever-widening spindle of deteriorated pulverized tracks. And as the original focal points were not static, but were moved from place to place according to changing requirements, the whole desert surface within the visible horizon became churned and overlaid by a deep mantle of dust (Plate 7). Nor did dust-disturbance cease entirely with the advance of our forces into Cyrenaica and Tripoli, following the battle of 'Alamein (late autumn, 1942).

With the new year (January 1943) demolition squads got to work with

[1] Plate 2 shows the lake bed prior to this.

[2] *Cf.* p. 33.

commendable promptitude, collecting and detonating the vast quantities of land-mines that had been strewn in protective mine-fields, together with such reserves of mines and other explosives for which there was no further requirement. These operations continued for seven or eight months (till August 1943) within our Burg perimeter. During the working hours it was usual to collect these mines into dumps. The mornings' work would as a rule be detonated about midday, and the afternoons' before sunset: six or eight explosions on each occasion.

To an onlooker each explosion took the form of a mighty uprush of smoke and dust rising to a height of perhaps 2000 feet. Normally this would show as a funnel standing on its point, whilst above, as the propulsive force exhausted itself, the mixture of dust and smoke would mushroom. Then the report of the explosion would be heard, and by counting seconds from the first visible uprush till the explosion became audible, it was possible to fix approximately the distance of the site. In calm or slight airs these mushroomed columns would drift slowly down-wind—often assuming grotesque and unexpected contours as they gradually dispersed.

Under conditions of absolute calm, towards sunset, the smoke-cloud would sometimes behave quite differently. The vertical shaft would become gathered together or contracted into a black ring, incorporating the entire visible products of the explosion. These rings floated horizontally at a height of 1500–2000 feet. They were notably stable, often persisting for twenty to thirty minutes till lost in the deepening gloom of sunset. Indeed, so permanent did they appear that it would not have been surprising had one of them survived till daybreak. Their diameter was of the order of 300 metres.

One imagines that under special calm conditions the ascending discharge acquires active spin from friction with the still air which surrounds the shaft of emission, and that this acquired spin confers on it a kind of rigidity. The rarity of this particular manifestation may be stressed: annular clouds were observed on five or six occasions in the period January–August 1943, and on warm, still evenings only. But when they did occur there would be several; a circumstance which points to the existence of particular conditions on those occasions. They suggest "smokers' rings" on a colossal scale.

These detonations, continuing for more than half a year in one locality, must have appreciably added to the reservoir of loose dust, and when the Burg perimeter had been cleared the demolition squads proceeded west continuing their work systematically. I can only state that their contribution to our dust-reservoir must have been considerable. In the circumstances a precise figure of the weight of explosives detonated is not to be expected.

It may be added that mine-fields, following the active operations of late autumn (1942), were often roughly fenced and marked with boards inscribed KEEP OFF with the added caution of a skull and cross-bones. This was to deter Beduins from wandering about in search of "souvenirs": booby-traps, and other dangerous gadgets have an irresistible attraction, and a child-like curiosity impels the Beduins to tamper with such trophies till something happens. "Unfortunate incidents" had not been lacking, nor were these occurrences in the long run without a restraining influence.

From the point of view of our subject-matter I drew the conclusion that

such areas, and they were extensive, were in time respected, and avoided by men and herds. That is to say there was less habitual traffic with disturbance of surface; whilst seedlings also would have a better chance of establishment than might otherwise have been the case. Consequently, on balance, the work of the demolition squads was ultimately beneficial, in spite of their initial spectacular performances. In this relation I noted many such areas on which bushes of Thymelaea were regenerating from seed.

The records

Vegetational years.—We may now proceed to the matter of the actual records summarized in the accompanying Table 1. These records are displayed not in the conventional "calendar" or month-sequence of the year (January to December), but according to what seems the more natural or "vegetational" year, beginning with October and running through to the following September. This treatment finds local sanction, as for a number of years the Egyptian Meteorological Service has started its "Rainfall Year" on October 1. It is at this date that the dry season usually ends and rains are expected. This subdivision gives a representation of the seasons proper to the subject-matter of a paper which relates primarily to dust-storms, the most important element in whose control is the vegetation carpet which follows the rains. All references in the text to dust-storm years are in consequence cited in the form 1940–41, which means October 1940 to September 1941.

Classification of dust-storms.—The ideal basis of classification of dust-storms would be a measure of their density: the weight of dust contained in some convenient unit of space—a cubic metre, perhaps. That line of approach implies specially designed dust-traps, dust-gauges on the analogy of rain-gauges—a mechanical contrivance capable of capturing a cubic metre (or other volume) of a dust-cloud, and then determining the proportion of dust. Such an ideal was entirely beyond the available resources of a remote desert village without a mechanic, or any priorities to provide the raw materials in war-time. When I returned to Burg el 'Arab in 1939 the matter of dust-storms was not in my mind, nor any plans relating thereto. I was unprepared. Then, under war conditions, dust-storm frequency increased and records were kept. As the occasion developed it became manifest that I was confronted with an unusual opportunity for gauging the relative fixity of desert soil—hence this report embodying the main observations over the six-year period.

The only dust-collecting chamber available, without experimental equipment, was an ordinary room, which, as is usual in Egypt, freely admitted currents of air with their burden of dust. In the relative calm the dust precipitates on horizontal surfaces. It was possible to take advantage of this circumstance in two related ways:

(i) To allow dust to fall on a clean smooth surface (glass, polished wood) of known area for such a period as an hour, then to collect and weigh the dust-deposit and express it in convenient terms, such as grammes per square metre, or tons per acre. The highest figures obtained in this way were of the order of $\frac{1}{2}$ ton per acre per hour. This was during the gusty turbulent dust-storm of 14 March 1941. More frequent figures would be $\frac{1}{16}$ or $\frac{1}{18}$ ton per acre per hour.

(ii) Correlated with this was a much quicker method, viz. to count under the low power of the microscope (magnification ×80, linear) the number of dust grains falling within a circle of 1 millimetre radius in a period of one minute. I found that thirty per minute corresponded approximately to $^1/_8$ ton per acre per hour—each grain of dust falling within the circle representing a contribution to the top dressing in the open of from 5 to 8 lb. per acre. The advantage of this method is that one's finger is continually on the pulse, as one might say. In violent turbulent gales, dust falls so rapidly on the slide that I found it impossible to attend to the whole area for the full minute, and had to be content to concentrate on a $^1/_4$ sector of the circle for some shorter period.

These methods are practicable only in a calm room. Their results are comparable with trying to obtain a rainfall record by collecting in jars the water that drips through a leaky roof. In other words, their value is limited. Out-of-doors they are impracticable, as a turbulent gust of wind may at any moment sweep clear the smooth surface of collection. Rough surfaces, such as fabrics with a pile, collect and hold the dust in the open, but it is difficult to correlate the results with those derived from smooth surfaces indoors.

Visibility.—The method of record adopted here is that of visibility from the station of observation. My house is provided with an open veranda extending from front to back and giving uninterrupted outlook in practically all directions. This platform being 13 feet above ground-level, and the observer's eyes about 5 feet above the platform, gives 18 feet as the height above ground-level at which visibility-determinations were made. This raising of the observer well above ground-level has in practice the effect of increasing rather than diminishing apparent visibility, thus providing an automatic check to any liability to exaggerate the density of a dust-cloud. The figures may therefore be accepted, if anything, as under- rather than over-statements.

A decision had to be reached at an early stage as to what degree of obscurity should be recognized and recorded as constituting a "dust-storm." It was decided that 700 metres should be taken as the critical distance for an "ordinary" dust-storm; that is to say that a tree or other object standing at this distance from the observer should be invisible. Higher densities are recognized as:

(*a*) "Very severe"; visibility 50 metres or less, and indicated in Table 1 by a dagger †.

(*b*) "Severe"; visibility 50–200 metres, and indicated by an asterisk *.

The distances from the observation station of the various objects used in fixing visibilities had been measured previously. All dust-storms here recorded are wind-raised and not traffic-raised. For inclusion in any one of the above categories the degree of visibility denoted must have persisted for a minimum period of one hour. A solitary gust is ignored.

The usual duration of a dust-storm is from four to five hours, though on occasion it may last all day. In the great majority of cases the wind drops towards sunset and the air clears. Frequently a storm resumes next day, or is succeeded by a following storm—these are recorded as two storms. Less frequently, a dust-storm may continue all night and well into the following day. This also is entered as two dust-storms, with an oblique stroke (/) between the dates in the record. The rule is, one day, one storm.

DUST STORM CALENDAR

Month	1939–40	1940–41	1941–42	1942–43	1943–44	1944–45	Month
Oct.	None	None	2 3 14 15 31	7 8 16* 17	2 10* 14	21	Oct.
Nov.	None	None	7 18 23	9 17 18 19 20†	3*	*1 18*	Nov.
Dec.	None	None	2 5 6	None	None	None	Dec.
Jan.	29	12* 16 18 19 25 28†	1 7 16* 24 28 30 31*	4† 5 10 27	1* 8 18/19	*5 30* 31	Jan.
Feb.	23	6 7 8 9 10 28	2† 3 4 11* 19 25*	22	6 8 15 17/18	None	Feb.
March	7	14† 15 21 22	17 22 25*	12 19*	*1 3 11 14 21 24* 26* 27†/28	31	March
Apr.	5* 13 14	7 9 12 14 17* 20 27*	14 18* 24 26*	9*	*1 2 6 7 12 16 27* 30	*30*	Apr.
May	14 18	6 8 10 13 14 24	4* 5 6 17 20	None	15 23 26	8 *9*	May
June	None	4 18 19 20	4 25 30	15	*7 13* 21 *27 29 30*	None	June
July	None	12 14 15 21	1 18 26 28 31	11*	*5 9 22 26* 27	None	July
Aug.	None	7 8	18 25	6	7 28	*18*	Aug.
Sept.	None	2	1 4 12 13 28	None	None	None	Sept.
Total	8	40	51	20	26+*20*	4+*7*	
Year's rainfall	106 mm.	83 mm.	106 mm.	165 mm.	100 mm.	247 mm.	

Table 1.—The vertical columns are arranged according to the vegetational year, *e.g.* the first, 1939–40, extends from October 1939 to September 1940. The figures in these columns are the days of the months on which dust-storms were recorded.—† Very severe, visibility nil to 50 metres. * Severe.

On very rare occasions short and violent dust-storms occur at night. Actually one only is recorded in the whole period (3 November 1943). As this lasted a full hour it qualifies for inclusion. There may have been others which failed to disturb my slumbers.

It may be stated here that in my experience no dust-storm ever approached Burg el 'Arab in the form of a spectacular advancing cliff of boiling black or red dust. That type is the one usually given in book illustrations, and is I suppose the only type which lends itself to pictorial representation. Had I included here a photograph of a local dust-storm, according to its degree of severity, it would show either just a general mistiness, or nothing at all. The explanation is that Burg el 'Arab is situated within the area of dust-storm generation. As the wind rises, there will be at first a slight mistiness, and according to the velocity and other qualities of the wind, this will increase till visibility deteriorates to an extent qualifying for recognition in one of the above categories.

Under this system of recording dust-storms it is evident that dust clouds of lesser density, with more extensive visibilities, such as 1000, 1200, or 1500 metres, would be ignored. This is true in the sense that precision details concerning them were not booked, though commonly their occurrence was noted in general terms. Had these visibilities up to, say, 1500 metres been included in the regular routine, it would have increased our numbers by perhaps 15 per cent. On the other hand, care was taken to differentiate those recorded into "ordinary," "severe," and "very severe." Looking back on the whole six-year period I now recognize that this approach was ill-advised. Had I envisaged the long duration of my vigils, and the course of the military operations, which at the outset were precautionary (Italy entered the war on 10 June 1940), I might have planned the records somewhat differently. For, as we shall see later on, these minor dust-storms designated here "sub-dust-storms" became relatively much more significant, so that in the 1943–45 columns of Table 1 their dates are included, and are set in italic (*cf.* p. 44).

Some selected examples of dust-storms

14 *March* 1941.—Perhaps the most severe dust-storm in density during the period covered was that of 14 March 1941—a sort of textbook example of a very severe Khamsin. The Meteorological Service of Egypt in its monthly weather summary for March 1941 describes it in the following terms: "An unusually deep depression was centred off Sollum on the 14th March, giving rise to strong S.E. gales and Khamsin conditions; very severe storms were experienced throughout Egypt, visibility at times being restricted to only a few metres, whilst in exposed desert places it was reported as nil . . . at Helouan the velocity of the wind reached 53 miles per hour." [1]

At Burg this dust-storm, raised by a strong south-east wind, closed over the district at 9 a.m. with a visibility of a few metres only. From 11 a.m. to 2 p.m. visibility was nil, and the darkness such that lamps had to be lighted

[1] These monthly summaries I have found to be a useful check on my records; to the Director of the Meteorological Service, Mr. L. J. Sutton, I am indebted for advice and information on many occasions. For measured records of local rainfall I am under great obligations to the officers in charge of the Burg el 'Arab horticultural station.

Table 1.—The vertical columns are arranged according to the vegetational year, e.g. the first column [illegible]

indoors. From 2 p.m. visibility improved, extending by 4 p.m. to 400 metres. While this storm lasted for about seven hours, its maximum density at zero visibility endured for three hours (11 a.m.–2 p.m.). The dust-cloud evidently reached up some thousands of feet from the ground and drifted far out over the Mediterranean, where it discoloured the paint-work of ships of the Royal Navy several hundred miles from the coast.

A striking feature of this dust-storm was its pulsating character. While for the most part the sun was blotted out, it became just visible as a deep red disk at rough intervals of five minutes. This periodicity may have depended on one of two causes, or perhaps on a combination of both. Either the actual density of the cloud varied, or the height of the cloud was inconstant, its upper surface being ribbed and not level—such undulations corresponding to a periodicity in the gusts.

By collecting dust on this occasion, as described on p. 34, it was found that the rate of fall in a closed room reached an amount equivalent to $\frac{1}{2}$ ton per acre per hour.

As the afternoon wore on the storm eased when the wind veered to west and north-west. This is the characteristic ending of most dust-storms of the Khamsin type. The following day (March 15) the wind resumed from the north sector with sufficient velocity to develop a minor dust-storm.

In the majority of cases recorded in the tables the average period during which visibility was reduced to 700 metres or less would be about four hours. Such storms generally began about 8 a.m. and would blow themselves out by the middle or late afternoon.

The storms of 26, 27, *and* 28 *March* 1944 were in part of the continuous type. On March 26 strong winds from south-east and south (Khamsin conditions) lasted till evening, when calm prevailed. Next morning, March 27, the wind freshened from the same quarter, bringing much dust, while in the afternoon it veered north-north-west without losing strength, and continued to blow all night from the same quarter (40 miles per hour), till midday on March 28.

This storm during the night of March 27–28 was remarkable for the intercalation of a short, sharp shower of rain, lasting five minutes, which drove against all windows facing west and north-west, thoroughly wetting them. This shower however was not sufficient to lay the dust-cloud which continued to drift from the same quarter till midday of March 28. The consequence was that the dust, which is colloidal and water-absorbing, congealed into a hard crust on these window-panes and had to be scraped off like paint. This is the only occasion in the whole six-year period on which this effect was observed.

3 *November* 1943.—This was a storm of exceptional type. In the early morning a violent and turbulent gale sprang up from the west-north-west sector, lasting an hour, 4.30 a.m.–5.30 a.m.; during which our flexible tamarisks were "boiling" and half prostrated. It was accompanied by a localized electric storm which circled round the village throughout the period. All the time there was continuous sheet-lightning of great brilliancy, with maximal flashes about every ten seconds. It was only during the last quarter of an hour that the storm was accompanied by thunder, which, instead of

manifesting itself in conventional thunder-claps, resembled the continuous pounding of great waves on a rocky shore. At the end of the hour the storm drifted away. There was no mistaking the violence of this display and the amount of dust that it carried, in spite of its brevity.

The "Freshet" type.—These were light showers of dust too brief for the routine records. On days of calm, or light airs from the east to south sector, puffs of wind up to 10 miles per hour lasting not more than fifteen minutes would spring up, reducing visibility to 1500–2000 metres. As the freshet died away the dust would clear. This type was frequent between July and December 1943. It may be conjectured that they derived from dry residual dust no longer detained on the ground by such remnants of desiccated herbage as still survived.

They differ from "sub-dust-storms" in that they were transient, and were raised by light puffs at 10 miles per hour. The "sub-dust-storm" was a reaction to stronger and more persistent winds at 16 miles per hour (*cf.* p. 44).

Taking all the dust-storms recorded from April 1941 to March 1944 inclusive (three years), the greater number, in the proportion of 5 to 4, came from the west and north-west sector. In the spring months however (January -May) the Khamsin type [1] is much more prevalent, *i.e.* dust blowing in from the south-east and south sector, though as a rule after a few hours they veered by south-west to north-west before calm was re-established.

Clearing of dust after a storm.—In general, following a dust-storm, while the main weight of dust is precipitated in the after-calm, there will remain in suspension sufficient finer particles to give the effect of a very thin haze. Thus, following a dusty day, a certain degree of dullness is shown by the night sky; stars, though clearly visible, are far from bright.

On 1 January 1944 we had a "severe" dust-storm which lasted from 9 till 4. By 4 p.m. the wind had veered to north-west and had fallen to slight, and later to calm. Happening to wake that night (night of January 1–2) at 3 a.m., I went to the window and looked out. To my surprise the whole firmament was alive with stars shining with a greater brilliancy than I ever remember. There had been no rain to account for this sudden transformation, and I can only suggest that possibly some electrical effect may have precipitated the residual dust. Such bright nights are familiar in Egypt, though less frequent over the desert than elsewhere. The moon, which was in the first quarter, had already set, and there was nothing to diminish the brilliancy of a spectacle new to my experience.

Following severe dust-storms, especially those from the south, one is impressed by the magnitude of the sprinkling of the landscape with fresh dust. This is especially noticeable on certain areas of which two examples may be cited. At the west end of Major Jennings-Bramly's property, on the ridge overlooking Burg from the north, is an old Roman quarry cut deeply into the ridge like a crater, and covering an area less than one acre. Scattered about on the floor of this quarry are numerous boulder-like rocks, fallen in

[1] The arabic word means "fifty": the implication being that there is liability to such storms within a period of fifty days included in the spring months, March–May. The name is traditional and popular, and should not be accepted too seriously as a scientifically defined term.

time past by earthquake action from the edge of the bowl. Visiting this quarry after a severe dust-storm, these boulders, and the ground between, were found to be smothered in a heavy top dressing of yellow dust, like new-fallen snow; and the crater being sheltered, it may be months before a heavy shower comes to wash it away.

On the lake bed between the two parallel ridges, extensive white areas develop in summer from the surface efflorescence of salt. These, after a heavy dust-storm, become shrouded by a mantle of yellow dust which may not disappear for weeks. A like effect was often noticeable on the white oolitic dunes (limestone) bordering the sea.

Commentary on the records

We turn now to the table recording the distribution of actual dust-storms, as defined by their relative visibilities (p. 36). It is evident from the nature of the measures taken in anticipation of hostilities and of the other attendant circumstances related, that the dust-potential (*i.e.* reservoir of available dust) must have been profoundly affected. All these operations, direct and indirect, must have made their contribution: the siting of camps, aerodromes, entrenching, and fortifying; the crunching and pulverizing of the surface by mechanical traction; the unregulated pulling of the natural protection of the surface; even the detonating of mine-fields and superfluous ammunition when the theatre of hostilities had moved elsewhere. It will be noticed that the number of recorded dust-storms for the first war-year, 1939–40, was eight; for the second, forty; and for the third, fifty-one. During the preceding five years the average number would have been three or four.

Assuming the provision of an adequate, *i.e.* relatively unlimited, dust-reservoir, the raising of dust-storms will depend on wind, the critical velocity for this purpose being, according to my experience, of the order of 12 miles per hour. Such winds are not very frequent. On calm days, together with such as develop an air movement that may be denoted as "slight", winds of 7 or 8 miles per hour form the majority. This holds good even in the windier months (January–May), while from June to December, twenty, twenty-five, or even thirty calm days per month are not unusual. Even in the year of maximal incidence (1941–42), with fifty-one recorded dust-storms, the average is just about one dust-storm a week.[1]

Humidity and plant cover as inhibiting factors.—As a rule when high wind is accompanied by heavy rain, there is no dust-storm. The dust is laid. Recovery from rain however is often rapid—especially when followed by hot drying winds from the south. Thus, to take an extreme example, on 28 December 1942, a very heavy shower on the desert near Burg brought a flood of run-off (*Seil*) which inundated the ground all around the village to a depth, in places, of several feet.[2] By midday, December 29, this had mainly disappeared, chiefly by percolation, leaving the surface sloppy. In spite of some further rain in

[1] Even in this year of maximal activity of dust-storms, under 5 per cent. of the entire span of time was so occupied. Averaged out, it means a trifle more than an hour a day all the year round. What is so impressive a quality of desert life, the calm and silence which generally prevail at the rising and setting of the sun, were rarely infringed.

[2] Plate 3 shows such a flood close up to the western entrance of Burg (13 January, 1937).

the first days of January 1943, a violent Khamsin gale from the south on January 4 was able to raise a "very severe" dust-storm.

A high relative air humidity also inhibits dust mobility to some extent owing to the colloidal character of the dust. However a hot wind from the south, with relative humidity 20 per cent., quickly dries it up again. On the whole, to this cause can be attributed little more than a slight delaying action. Even a north-west gale off the sea, with relative humidity 70–80 per cent., can raise dust surprisingly quickly.

Apart from sluggish airs and humid conditions, the degree of covering of the surface by vegetation must not be lost sight of as a stabilizer of dust. This will appear in due course (pp. 48–9). From this angle a plant is a trap to catch dust.

The dust-reservoir and its fate.—It is not possible, except at undue length, to analyse in detail the circumstances of the dust-storms of the years 1940–41 and 1941–42. We must be content with the statements that these were both years of low rainfall (83 and 106 millimetres respectively) and of sparse vegetation, and that the frequency and velocity of wind for these years was in no wise excessive as compared with the preceding years; if anything they were less windy than 1939–40. Consequently, the dust-storm frequency would appear *a priori* to derive from the abnormal and artificially produced surplus of dust due to causes set forth above.

By 1943 the zone of hostilities moved away west, and a point of some interest arose. As ground disturbance gradually subsided, would the inflated dust-reservoir be consumed without replacement, and dust-storm frequency revert to normal? Or, on the other hand, was it possible that the artificially created erosive process, once started, would become chronic? In America and elsewhere it is recognized that wrong management of land has often been the operative cause in initiating certain types of erosion ("dust-bowl" phenomena) which, once started, have been found to require drastic methods to eradicate. As one may say, erosion sometimes breeds erosion.

How would our desert react now that it was about to be left relatively to itself once more? Would it gradually recover, following the exhaustion of the artificially created dust surplus, or would such dust production persist as a sort of acquired habit?

Finally, would the scrub that had been destroyed, depriving the surface of its natural cover against wind, regenerate from the reserve of seeds nearly always dormant in desert soils?

Three years in detail: 1942–43, 43–44, and 44–45. From the columns for these years, it is evident that dust-storms have become less frequent, and have fallen from fifty-one in 1941–42, to twenty in 1942–43, twenty-six in 1943–44, and four in 1944–45. As these years appear to mark a transitional phase which may be critically important, they merit fuller consideration.

So far as my experience of the Maryut flora goes it would appear that two conditions must be fulfilled for the production of a good display—which is largely based on annual plants: there must be a total rainfall extending over the period October–April considerably in excess of the mean, which is about 115 millimetres, and the showers which bring the rain should appear at frequent intervals—the ideal being a good shower every ten days, with

maximal incidence in January. It was in such conditions, obtaining in the winter and spring of 1937–38, that a bumper display hardly known in living memory was produced. The nearest approach was in 1929–30; also a season of high rainfall. The four following seasons (1938–39 to 1941–42) had an average rainfall of 103·5 millimetres (the extremes being 83 and 119), with production of sparse flora and very little barley.

Table 2. Monthly Rainfall in Millimetres

	Oct.	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*March*	*Apr.*	*May*	*June–Sept.*	*Total*
1942–43	20	14	25	43	28	19	11	5	none	165
1943–44	17	6	22	34	19	2	none	none	none	100
1944–45		Oct. to Jan. 165			56	17	4	5	none	247

Details of rainfall for the vegetational years 1942–43, 43–44, and 44–45 (Burg el 'Arab) are contrasted in the text, below

Details of 1942–43.—In 1942–43 there was marked increase in rainfall on the preceding years, as set out in Table 1. The distribution in time was also excellent (Table 2): fairly even monthly amounts in the first three months (October–December); heavy rains in January, with gradual decline till the summer's drought.

The progress of plant establishment was as follows. By early January a generous germination of seed was apparent on all classes of terrain—the higher plateaux, slopes, and lower ground. With a copious rainfall continuing, these seedlings, which started out as mere points, gradually expanded so that by the end of January they must have covered almost half the desert surface. February and March continued the good work, so that at its maximal spread the wild flora occupied on the average quite three-quarters of all the ground.

In this display three Cruciferous species (all annuals) played the most conspicuous part, *Carrichtera annua*, a white-flowered congener of the mustard; *Enarthrocarpus lyratus* (cabbage tribe), yellow petals with purple blotches; and *Matthiola humilis*, the mauve-coloured sea stock—the relative frequency of these three species was in the order of their enumeration. In habit they were all of the more or less prostrate type and they continued to expand right through the season up to May and even June. Quantities of other plants cooperated with these, but as this is not primarily a botanical paper, two only may be mentioned by name: *Centaurea glomerata*, a prostrate, yellow-flowered composite which crawls on the ground, continually forking; its mats often reached a yard in diameter that year. The other, a trailing annual of the Leguminosae, *Trigonella stellata* (one of the fenugreeks), with bright yellow heads of sweet-scented flowers.

During February there were two occasions when the wind blew hard. The first, on February 12–13, of Khamsin type from the south, failed to produce a dust-storm. Later, on the 22nd there was a violent squally gale from the north-west (50 miles per hour in the gusts): this raised a dust-storm. In March there were high winds on eight occasions. On the 12th and 19th dust-storms were recorded, on the 21st rain fell in quantity, keeping the dust on the ground; while on five other days, when strong winds blew, any dust

raised was negligible. In April there were six days of high wind; that on the 9th produced a severe dust-storm. Another on the 12th was accompanied by rain, while on the four remaining occasions dust again was negligible. May was a month of calm weather mainly—on four days there were fresh winds blowing (15 miles per hour), but no dust-storms were raised.

During the four remaining months (June, July, August, September) the weather was mainly calm, apart from a total of thirteen days on which winds of 25 miles per hour developed. Of these winds those on June 15, July 11, and August 6 alone were accompanied by dust-storms. This leaves ten windy days during this period when no dust was raised considerable enough for record.

Summarizing these eight months, February–September inclusive, there were thirty-two days of high wind (omitting March 21 and April 12, when the wind was blanketed by rain) of which seven raised dust-storms of various categories, while twenty-five failed to raise appreciable dust.

This was an experience without precedent in 1940–41 and 1941–42. The decline in dust-storm incidence must depend on some factor absent in the two seasons cited. It can be related only to the well-developed vegetation mantle of 1942–43. Exploring the ground repeatedly it was perfectly obvious that the plants were holding the dust. That they continued thus to function right on into the autumn depended on the fact that even when their shoots and leaves dried up under the summer heat, there was no disintegration till much later. Indeed it is probable that the new-brought dust, held by these plants, operated as a fertilizer and promoted maximal growth, *i.e.* so long as moisture was available.

It may be emphasized that this was the first year within the war period in which the natural vegetation was sufficiently developed to operate as a controlling factor in relation to the dust nuisance.

Details of 1943–44.—Climatically this year contrasted with 1942–43 in that the rainfall which started, not without promise, with 17 millimetres in October, and up to the end of January was adequate for the establishment of seedlings, failed thereafter. After February 8 (apart from a brief shower in the night of March 27–28) no rain fell in Burg (*cf.* Table 2). Consequently there was no effective expansion of seedlings as had been the case the previous year. Right up to midsummer the unit plants rarely reached a diameter exceeding a few inches, instead of feet as in 1943. If the vegetation covered 75 per cent. of the ground in 1942–43, in 1943–44 it did not exceed 10 per cent.

This sparsity of the carpet in the latter year would appear therefore to stand in direct relation to the recorded increase in dust-storm incidence.

Details of 1944–45.—This was a year of unusually heavy rainfall, with total of 247 millimetres. The major part fell in the four months October–January (165 millimetres),[1] and was followed by 56 millimetres in February. Vegetationally the spread of plant cover was complete, though the actual floral display at any one moment was less impressive than that of 1937–38, when spells of cooler weather retarded premature flowering until March.[2]

That dust-storms should have diminished markedly in such a season was inevitable in any case. The fact that even when the cover died off (June–

[1] From accidental circumstances the total only is available for the four months.

[2] *Cf.* "Flowers of Mareotis," *Trans. Norf. and Norw. Nat. Soc.* 14 (1938) 407.

September) only one dust-storm was recorded (and that a sub-dust-storm *cf.* Table 1) indicates that the dust-reservoir was by this time largely depleted.

Sub-dust-storms.—This however is not a complete statement of the position. Already (p. 37) passing reference has been made to what have been classed provisionally as "sub-dust-storms," *i.e.* such as failed to reduce visibility to 700 metres. Had these been included, dust-storm incidence would have been increased numerically by 10–15 per cent.

Now, during the period February–September 1944, there were eighteen dust-storms with visibility 700 metres or less,[1] and twenty sub-dust-storms with visibility of 1000–1500 metres, as Table 1 shows. These latter were raised by winds of intermediate velocities averaging about 20 miles per hour, which according to the experience of previous years (excluding the spring of 1943 when there was good vegetation cover) should have raised dust-storms having visibility restricted to the 700-metre limit.

My suspicion that we were entering a new phase was aroused, and the state of the surface was examined on many occasions and along various radii. It appeared that the surface was slowly hardening—in other words that what has been termed the "reservoir of dust" was approaching exhaustion. Lack of dust was becoming the limiting factor. This matter is pursued in the next two sections.

Wind velocities and dust-storm types.—It is convenient here to consider the relation of wind to dust-storms (including sub-dust-storms) at different periods with a view to gleaning evidence on the exhaustion of the mobile "dust-reservoir," whether by attrition, *i.e.* deflation, or by consolidation with the desert surface. It is evident that following the march of our armies west after the battle of 'Alamein in December 1942 a main factor in abnormal dust production would cease to operate, although this may have been somewhat retarded by the subsequent activities of the demolition squads from January to August 1943 (*cf.* pp. 32–3) in removing the local mine-fields. For the purpose of contrasting the dust-reaction to wind in the several years reviewed, the period February–September is taken throughout, whereby the blanketing effect of rainfall is largely eliminated. For comparison, dust-storms are grouped in three classes—"ordinary," "severe and very severe," and "sub-dust-storms" (Table 3).

Table 3. Wind Velocity in Relation to Types of Dust-Storm

Feb.–Sept.	*Ordinary D.S.*	*Mean wind vel.*	*Severe and v. severe D.S.*	*Mean wind vel.*	*Sub-dust-storms*	*Mean wind vel.*
1941 ..	31	16 m.p.h.	3	29 m.p.h.	—	—
1942 ..	26	18	7	26	—	—
1943 ..	4	28	3	37	—	—
1944 ..	16	27	2	40	20	16·5
1945 ..	2	35	0	—	3	25

The outstanding feature of this table is the contrast presented between the mean wind velocities required to produce the same results in the earlier and

[1] This compares with seven for the same period in 1943.

later periods. In the years 1943 and 1944 the wind velocity necessary to raise "ordinary" dust-storms had increased by about 10 miles per hour as compared with 1941 and 1942. In other words, the mean velocities previously required for the more severe types had now become competent to generate only "ordinary" dust-storms of 700-metre visibility. In 1945 this mean velocity requirement had risen to 35 miles per hour.

Sub-dust-storms are cited for 1944 and 1945. In the earlier period such storms were associated with a low relative wind velocity such as 7 miles per hour, while in 1944 they were accompanied by winds averaging 16·5 miles per hour, which is substantially the same as was required in 1941 and 1942 to produce an "ordinary" dust-storm of 700-metre visibility. Further, these twenty sub-dust-storms came in two groups: eleven in March–April, and nine in June–August. The mean wind velocity of the earlier group was 13·9 miles per hour, and of the later 19·7 miles per hour. In 1945 the mean wind velocity for sub-dust-storms had risen to 25 miles per hour.

Broadly speaking, these figures indicate that with passage of time much higher wind velocities were required to produce the results for which lesser winds had sufficed in the earlier phase. In other words the mobile dust-reservoir was now becoming less effective as a source, either through depletion, or perhaps by consolidation.

The immediate effect of the departure of our Forces in December 1942 was masked by the very adequate plant cover which spread itself everywhere as from January 1943. Table 3 shows seven dust-storms (*i.e.* four "ordinary" and three "severe") for the period February–September 1943, as compared with thirty-three in 1942 (twenty-six "ordinary" and seven "severe"), *i.e.* a shrinkage to less than one quarter. Evidently depletion of dust through deflation must have been greatly retarded, while a further effect of the plant cover may have been to accelerate consolidation of dust by raising moisture from lower levels together with any direct shelter from evaporation such cover might afford. This latter point will require a special investigation in a suitable season for its elucidation. The data displayed in Table 3 are no more than a record of what actually happened under the free play of natural forces combined with successive phases of military disturbance: it was no planned scientific experiment of the nature suggested above.

Otherwise, these three seasons (February–September 1943, 44, and 45) are in general agreement as to the need of increased wind velocities to produce the effects of the earlier phase (1941 and 1942). This agreement however depended on different causes, in 1943 on plant cover, in 1944 on a more intractable soil which it may be conjectured was due to a process of soil consolidation. The section which follows appears to be consistent with this idea of auto-recovery of disturbed desert surfaces.

The abandoned camping-grounds.—An accidental circumstance extending over the period midsummer 1943 to April 1944 provides valuable testimony in this matter. This relates to a strip of desert ground about $1\frac{1}{2}$ miles long (east to west) and $\frac{1}{4}$ mile deep (north to south). It lay just north of Burg el 'Arab and extended from the north-east corner of the Horticultural Garden to a point on the level just south of Major Jennings-Bramly's house. Unlike so much of the ground about Burg this strip had not been camped on till mid-

summer 1943, though its surface had been previously highly mobilized everywhere by lorry traffic. Three small separate camps were established on it at the date given; an Indian battalion occupied the east half of the strip; the central section was allotted to an R.A.M.C. unit; while at the west end was another small camp where Red Cross ambulances were parked and serviced. Now it happened that all three camps were evacuated at the same time, viz. the week-end 7–9 April 1944, and all camp furnishings, tents, etc., removed. Following April 9, there was no interference or traffic of any kind on the sites of these camps; in fact the wire entanglement fences had been left in situ, so that interference was impracticable.

Keeping these lately evacuated sites under observation I noticed that much dust had drifted on to what had been sheltered alley-ways between tents and other camp erections (this is usual with camps—dust comes to rest and accumulates between obstacles where it finds shelter); that whenever the wind blew at more than 10–15 miles per hour the sites of the three abandoned camps were "smoking" with dust—three little, isolated dust-storms. Wind was now finding access to those previously sheltered spots, and the accumulations of dust were being gradually shifted—a state of affairs which continued throughout the rest of April, May, and June, whenever such wind velocities prevailed; and that on the other hand the adjacent ground which had not been camped on did not liberate dust except under very much higher wind velocity, 20–30 miles per hour.

It would appear therefore that chance circumstances had provided a sort of "lecture table experiment" demonstrating: the high mobility of the ground of just evacuated camp sites; and the capacity of adjacent terrain, rendered mobile by traffic at a much earlier period, to recover up to the point at any rate of not feeding the gentler winds but requiring higher velocities (20–30 miles per hour) to ruffle its tranquillity. Had the whole thing been designed and carried out with the help of a labour squad the details could not have been improved on. The point of this observation of abandoned camp sites is the simple and convincing way in which it differentiates between old ground, well advanced in restabilization, and adjacent ground whose mobility has been rejuvenated through military disturbance. In this case it required about twelve weeks for the camp sites to recover and enter the more resistant phase. The incident occurred in a very dry year (1944) so that no complication arises from the presence of vegetation cover.

Some inferences.—The evidence indicates that desert ground of this type if left to itself after surface disturbance does tend to stabilize itself, at any rate within certain limits of wind velocity. But that such recovery can be absolute in a countryside like Maryut, infested as it is by Beduins and their live-stock, is improbable. From time immemorial Maryut has been liable to occasional dust-storms (three or four a year since 1930); and any one who has had experience of the penetrating and searching power of hurricane weather of 50 miles per hour in this district would probably agree. Nothing less than a continuous vegetation mantle with ample provision of shelter-belts of scrub and tamarisk could cope with such conditions. However the present article claims to be no more than an objective report on a definite experience; desert planning is beyond its scope.

Change of phase.—And now to return to the dust-storm tables. At the outset three degrees of visibility had been devised as suitable for record, the greatest visibility degree for formal recognition being 700 metres. At that time, when surfaces were subject to traffic and other disturbance (p. 31), there was available a growing dust-reservoir from which practically all winds over 12–15 miles per hour (unless blanketed by rain) could raise dust-storms within the defined limits. At a later stage an increasing number of sub-dust-storms, giving visibilities of 1000–1500 metres, became noticeable; these attained maximal incidence in the period March–June 1944.

The presumption is that the phase of greater activity is drawing to a close. Had I permitted myself at the outset to let my mind dwell on possible sequels, one would have been the inevitable decline in the incidence of dust-storms. The catastrophic is transient. Consequently in those earlier days, though distant haze on the desert was frequently recorded, these entries were not generally accompanied by wind velocities, instrumentally taken. In the circumstances the original plan of record has been retained throughout, except that when these sub-dust-storms could no longer be ignored, and indeed appeared to be significant, I have since February 1944 included them in the tables. The dates of these sub-dust-storms are set in italic in Table 1, thus—*6*.

In the spring of 1941 (March–June) there were twenty-one dust-storms; in 1942 (March–June) fifteen. In the same period of 1944 the number had declined to ten, with the addition of sixteen sub-dust-storms (visibility 1000–1500 metres).

It may be added respecting 1944, that the average wind velocity raising those ten dust-storms was 30 miles per hour, while the corresponding figure for the sixteen sub-dust-storms over the same period was $16\frac{1}{2}$ miles per hour. In the earlier days of my records, other things being equal, a wind of $16\frac{1}{2}$ miles per hour would have raised dust-storms with visibility reduced to 700 metres or less. To-day such winds produce no more than sub-dust-storms. Evidently the texture of the desert surface is growing more resistant.

The spring of 1943 (with four dust-storms in the same period, March–June) was not comparable with either of the two preceding springs, nor with that of 1944, for the reason that it alone of the three had an ample vegetation carpet.

The lake bed.—In concluding this section some reference must be made to the dust contributions deriving from the lake bed (salt marsh) area lying between the two parallel rock-ridges to the immediate north of Burg. As stated on p. 32 its vegetation was severely destroyed in the earlier years of the war. Following this a forward hospital was established there in 1942 with constant traffic of ambulances, as well as of aircraft on a temporary landing-ground. The surface, already denuded, became thoroughly churned up and much loose dust accumulated. Even in September 1944, though there had been little traffic on the lake bed for eighteen months, it was still a source of dust-clouds under wind from the west and north-west. Its "reservoir" was not then exhausted. The greater the westerly component, whereby the wind blows directly or obliquely along this valley, the greater the movement of dust.

With winds due north and north-east, when the wind blows transversely across the valley, owing to the diminished "fetch" and the appreciable shelter given by the northerly ridge, less dust is set in motion. As the salt marsh vegetation (largely perennial) re-establishes itself the surface should stabilize once more. Plate 2 shows the pre-war phase; for its present appearance it is only necessary to wipe out most of the foreground.

Dust-storms and rainfall

Table 1, while presenting in detail the dust-storm incidence for the six war years (1939–40 to 1944–45), includes a statement of the relevant rainfall totals. Of these totals, two stand out from the rest, 1942–43 with 165 millimetres and 1944–45 with 247 millimetres. The other four, all deficient in amount, average 99 millimetres per annum.

Such fluctuations are characteristic of the district. To go no further back than my own contacts: 1929–30 was a season of abundant rainfall (well over 220 millimetres) with fine display of plant cover and barley crops. This was followed by a series of seven more or less lean years, over which the rainfall averaged about 120 millimetres per annum. Then came 1937–38 (257 millimetres), with bumper crops and a spread of wild flora such as the oldest inhabitants had not seen for forty-one years. To me it seemed like a miracle. The next season (1938–39) showed a deficient rainfall (119 millimetres).

This variable type of rainfall is evidently of very long standing, and accounts for the many hundreds of collecting tanks (cisterns) and other contrivances along this coast-line which have survived from ancient times. Those old peoples were well aware of the potential fertility of desert soils when mixed with water, and possessed the skill and tenacity to make the necessary provision. With the Arab conquest (seventh century A.D.) came a set-back, and it is only in recent years that (apart from barley) the older cultivations are being revived.

But to return to Table 1. The years 1940–41 and 1941–42 were the peak years for dust-storms (forty and fifty-one respectively); they were also the two years of maximal disturbance of desert surface, as well as being years of drought.

When the armies marched west (winter, 1942–43), apart from clearing of mine-fields and the like, there remained little local ground activity to swell the dust reservoir. Dust-storms fell to twenty, this sudden contraction in number being largely dependent on the plant cover promoted by a rainfall of 165 millimetres.

The last year of the series (1944–45) shows a most marked diminution of both standard and sub-dust-storms—the numbers almost approximating to pre-war. The highly developed plant cover of this year, corresponding to a very abundant rainfall of 247 millimetres, would in itself account for this until it died off at the end of the spring. None the less the later months of the season (June–September) showed no increase in dust-storm incidence, as for that period the record shows only a single sub-dust-storm (Table 1).

Concurrently, the perennial desert scrub which had been so heavily sabotaged in the earlier war years showed continued rejuvenation, in which relation the marked increase of vigorous young plants of *Thymelaea* (a key-

plant) may be stressed. The lake bed which suffered severely is also recovering and should resume its pre-war spread within a year or two.

On all counts the dust episode that accompanied the various operations of war has now subsided: nor is there any evidence of the severe erosion phase to which the desert surface was subjected in the earlier years having any permanent deleterious effect.

The following year (1943–44) was one of drought with much greater exposure of surface due to paucity of cover. The number of dust-storms of types as previously recorded rose to twenty-six, and in addition to these there were twenty sub-dust-storms (visibility 700–1500 metres) raised by wind velocities which on the precedent of 1940–41 and 1941–42 should have raised dust clouds of full standard type. Frequent inspection of familiar ground however convinced me that the volume of loose dust on the surface was becoming seriously depleted, and that exhaustion of the dust reservoir had become the limiting factor.

In the branch of meteorology which relates to dust-storms three principal variables are involved: wind velocity, plant cover, and available dust reservoir. Actual rainfall in its direct action as a stabilizer of the surface is relatively transient in its action. In a wind, and especially in a hot wind, surface dust dries rapidly—often in a few hours. The true significance of rain in this matter is its indirect action as a promoter of plant cover. In this relation there is analogy between plant cover on a desert and wind-raised dust, on the one hand, and the protection against water-erosion afforded by forest canopy on hilly ground, on the other.

In the foregoing account little reference has been made to the biological aspect of dust, apart from the restraining action of plant cover. From that angle a variety of matters arise, including: the composition of dust and its fertility value in relation to vegetation; its effects on the animals of the desert; the opportunity afforded by the natural regeneration of areas denuded of scrub for the entry of other perennial plants which might become permanent members of the scrub community; and measures for the control of dust drift at ground level, especially by appropriate planting. These and other topics proper to the biological field may conveniently be postponed to a later occasion.

MAKING AN OUTLET FROM LAKE BANGWEULU IN NORTHERN RHODESIA

W. V. BRELSFORD

TOWARDS THE end of 1942 I started to make an outlet from lake Bangweulu so that loaded power boats could pass from the lake into the Luapula river. The main purpose was to enable Government to transport cassava to the Copperbelt of Northern Rhodesia, where war-time conditions and great increase of staff had made this an important emergency food for the African workers. The shores of lake Bangweulu are thickly populated and the ten thousand bags of cassava needed annually could easily be produced. There are two roads touching the lake, one at Nsombo on the north-east and one at Mwamfuli on the west. The former had been used for lorry transport of food to the Great North Military Road and the latter for direct transport to the Copperbelt. The water transport to buying depots and the road heads had been by dug-out canoe.

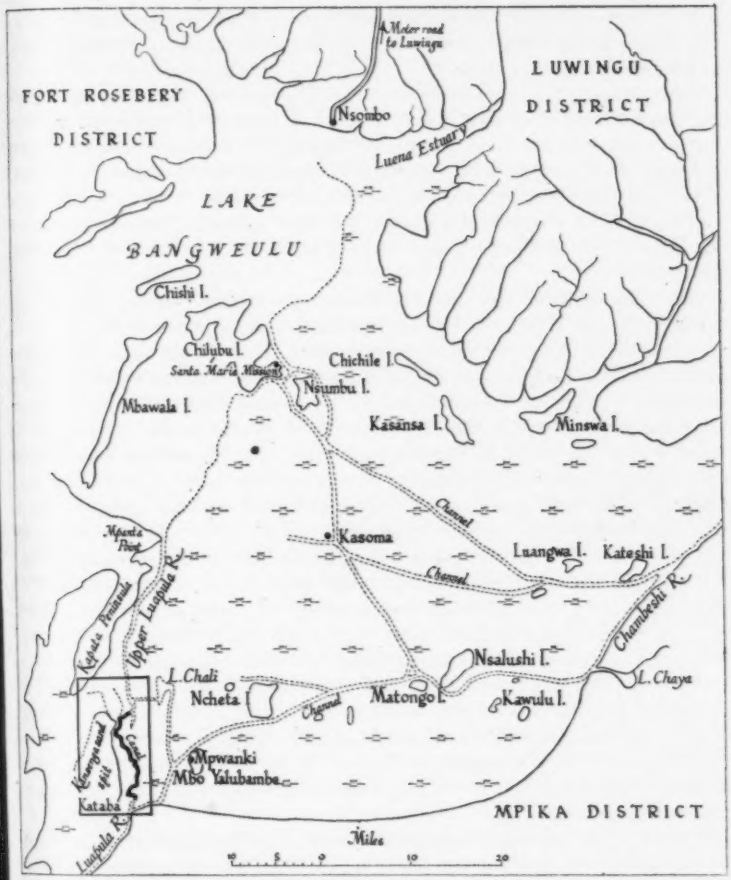
By 1942 lorries were so scarce that the scheme of making a water outlet from the lake was pressed. If such an outlet could be made to carry powerful boats it would be possible to take the meal by water from the lake depots into the Luapula and down to Kapalala, which is only 60 miles by road from the Copperbelt. Mwamfuli, on the lake shore, is about 160 miles, so the saving in lorry and tyre wear would be considerable.

As District Commissioner, Luwingu, I was put in charge of the scheme. In 1942 Government voted one thousand pounds as a token sum to start making the outlet. In 1943 I also began work on a power-boat route through the swamps to link up with the new outlet. Five thousand pounds was voted for the general schemes of which approximately half was for the outlet work and for the purchase of boats. In 1944 a further five thousand pounds was voted of which nearly half, again, went on the outlet scheme and boats. In later years maintenance money rather than capital expenditure will be needed, although several thousands of pounds are being voted for 1945. The scheme is thus expensive. This paper however is concerned with the practical and geographical aspects, so I quote these figures only to show the value set on the scheme.

Whether there ever has been an open-water outlet from lake Bangweulu is very doubtful. The Chambeshi is the main feeder of this large drainage area, but at the beginning of the swamps this river is gradually narrowed by papyrus and its water lost in countless channels. Some get to the lake, but the changes of current that can be seen in the swamp channels prove that there is a very complicated series of levels. The Chambeshi comes out of the swamps again at the south-west corner where an open stream is gradually formed, close to Mbo island, which shortly joins the Luapula at Kataba.

Some published maps show the Luapula running out of the lake as a single stream from Mpanta Point. Whatever it did in the remote past the Luapula has certainly not come straight out of the lake during this century. From

Mpanta Point it runs in a clear, wide open course for about 30 winding miles, then close to Kansenga it gradually narrows and, like the Chambeshi, its water disappears into the papyrus. About 15 miles due south another stream appears. It is a typical swamp stream, only 12 yards or so across at low water, as against the 100 yards or more of the vanished Luapula. But this is the



stream that joins the Chambeshi at Kataba and is the real beginning of the great Luapula.

It appeared that this stream was a contracted continuation of the Luapula, and all we had to do was to dig a channel through about 15 miles of sudd and papyrus to join the two streams again and we should have our outlet. Natives said that the Luapula once did run here, so we thought that the information on some maps might be correct. But when we got into difficulties I began to

press for more definite information and for particulars of the actual route of the river. Then, of course, the usual result was reached: no one had actually seen the river flowing; nor could any one remember their fathers saying they had really seen it. In fact it had seemed as obvious to them as to us that the river from the north should have been joined to the one from the south, so a sort of legend had grown up that they were once joined. There had always been a narrow dug-out canoe route past Kansenga between lake and Luapula, but such a path, where canoes had to be dragged through papyrus or mud, could not be called an outlet.

The earliest map is, of course, that of Livingstone, who discovered lake Bangweulu, and dates from the years 1866 to 1873. It is published in 'The last journals of David Livingstone.' Livingstone did not live to see the outlet, although the high ground by Mpanta Point was shown to him in the distance. On his map he shows Webb's or Luapula river running out of the lake northwards. It is obvious that the natives did not explain to him that the river made the huge bend south and westwards before turning north to reach lake Mweru.

The *Geographical Journal* of February 1893 contains the map of 1890–91 made by Joseph Thomson. He did not visit the lake, but on his map he gives the route taken by Giraud in 1883, and by then the Luapula was shown more or less correctly as flowing southwards from the lake. Giraud left the lake by the upper Luapula at Mpanta Point and he seems to have followed the river until the high ground at Miloke. Then he took what is the normal canoe route, which cuts off all the bends of the river, into Kang'wena lagoon and he touched Kapata and Chisamba's village on lake Kampolombo. So that Giraud too missed the section of the Luapula with which I was concerned. Poulett Weatherley, in his map of lake Bangweulu (*Geogr. J.* 12 (1898) 241–59), shows the Luapula flowing as a definite river right through the swamp, but as he did not visit the area he must have relied on native information.

In 1899, L. A. Wallace touched the Luapula at Chongola where the river, as he says, "emerges from the swamp" as an open channel (*Geogr. J.* 29 (1907) 369–95). At Chongola the river certainly is a wide open channel, for it is many miles below the confluence of the Chambeshi, which itself is a wide open river from well upstream of Mbo island. Wallace mentions a Captain Bright who had collected canoes and paddled "with much discomfort but no great difficulty" from Chongola to Mpanta. This hardly implies a continuous open route, and it has always been possible for canoes to get from the lake to the lower Luapula.

There are two other interesting statements in Wallace's paper. One is that in his opinion Bangweulu had been higher than it was in 1899 and that Kampolombo had been joined then to the main lake. The other is that the seasonal fluctuation of Bangweulu is only about 2 feet. I set up posts in 1943 at Nsombo and Chilubi island and a fluctuation of approximately 4 feet was measured.

F. H. Melland's map in the *Geographical Journal* of October 1911 is interesting, as the amount of open deep water shown is very considerable compared with that to-day. But it only gives the "approximate course" of the upper Luapula.

Thus the early maps give no indication of any open water outlet from Bangweulu, and perhaps the fact that Giraud and Weatherley left the Luapula close to the outlet in order to strike across country to the river lower down its course, may indicate that they knew that it became lost in the swamps for a long distance.

The later evidence shows that there was no open water outlet from 1910 onwards. J. E. Hughes's book, 'Eighteen years on lake Bangweulu,' covers the period 1910–19 and we have official information to follow on after that. Boundary disputes settled in 1911–14 and discovered in official records at Luwingu quote natives as saying: "After Kansenga the river goes underground," and the Paramount of the time said, "the Luapula is the boundary to the place where it disappears into the swamps."

From all this evidence it is fair to deduce that for almost a century there has been no open water outlet from the lake, and that the Luapula closed in the region of Kansenga and its water trickled out through the swamps along a broad front. The water of the Chambeshi river, the greater feeder of the swamps, after much meandering also flows south-west to the Luapula water.

The water-level in the swamp has been gradually rising for the past decade; this appears to be a cyclical rise and is not caused by any such phenomenon as the silting of an outlet, as the water has always gone out through the swamp. The earliest record indicating water-level comes from tribal history, for in the 1890's the raiding Bemba tribe chased the Baunga on foot from the east as far as Musubilwa lagoon, on Kasoma channel, now about 30 miles inside the swamps. It was only from here the Baunga could escape by canoe. Chief Kasoma, who was a young man then, told me that in those days it was possible to walk from Kasoma to the Luapula at Mpanta in the dry season. The next record is in the diary of the Santa Maria Mission on Chilubi island. The Father who founded the Mission in 1903 states that only about 200 yards of water then separated the island at Santa Maria from dry land at Chabukasansha. Now there are about 2 miles or more of water. The next record in the District Commissioner's files at Luwingu is that the water had risen so high in the swamp in 1910–11 that the Baunga were starving. Melland's map also shows a much greater area of open water than there is now. The level seemed to fall about 1920. After that year there was a slight rise to about 1927 followed by a fall ending in 1935. Since then there has been a steady rise up to 1944. An additional object of our work in making a clear-water outlet from the lake was to get the water away quicker and thus help to lower the level in the swamp.

In order to complete the description of what happened to the Luapula after leaving the lake, I should mention the lake Chali area. This is a large open sheet of water in the swamps to the east of Kansenga. It is one of the best fishing-grounds, and Hughes mentions the narrow canoe track from Kansenga that pushes through the papyrus to lake Chali. The lake is shallow, but from its eastern end a strong, wide, and clear river flows southwards through the swamps to join the clear Chambeshi as it emerges from the swamps by Mboyalubambe island. This route, from Kansenga, is the only indication of what might have been an open water continuation of the Luapula, for it is deep water all the way except in lake Chali itself. But lake Chali is not shown

or mentioned by any of the early map-makers, and here again, as far as one can gather, the section from Kansenga to lake Chali has, in tribal memory, always been a narrow, hidden canoe track through the papyrus. Melland's map shows an open lagoon in the approximate position of Chali, but he does not mention it or the canoe track from Kansenga.

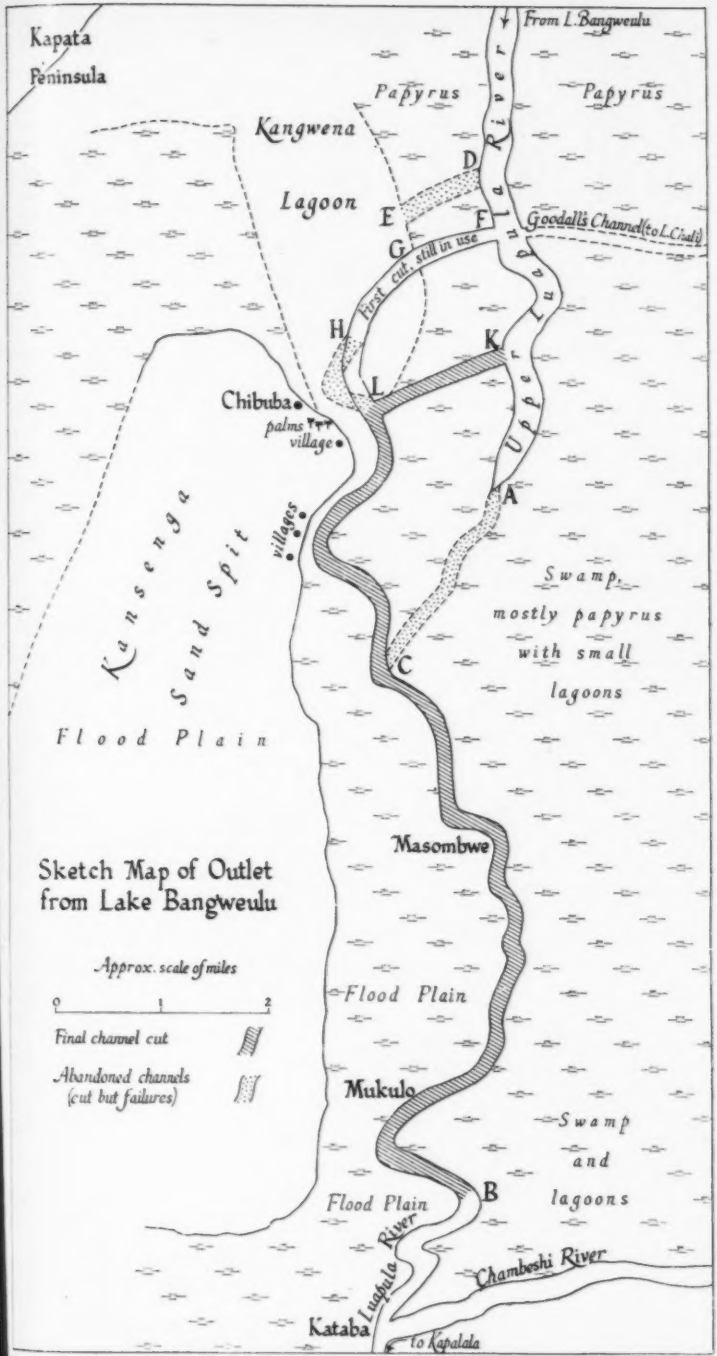
The latter was opened into a wide channel during the 1914–18 war by the late E. H. B. Goodall for heavy canoe and barge traffic. We did consider opening it for our power-boat traffic, but it would have been a much longer route, and entirely through swamps; moreover from Miloke to Kataba would have been at least a three-day journey upstream with no solid ground or sleeping places on the whole section.

In the dry season of 1942 in August a narrow pilot canal was dug from the point where the Luapula disappeared into the papyrus to the open channel about 15 miles farther south (the direct line A–C–B on the sketch-map). When the link was made there was a current flowing down the pilot canal and deep water in many places. So I began to widen the canal to approximately 30 feet.

There are two points I should emphasize here. First, that the work was being done without a survey of any kind. It was in the middle of the war and Government could not spare either a surveyor or a Public Works Department engineer to visit the work. The military authorities were interested in the through Chambeshi route but could only assist by offering to photograph the area from the air, and that would not have helped to find a channel route. It might have shown us the relative positions of lagoons and channels, and we were foolish not to have pressed for air photographs.

Secondly, all the work was done by hand. The use of a dredger or other mechanical help was out of the question during the war. Even the first steel barges and the diesel power unit that eventually made use of the outlet were made on the Copperbelt by miners in their spare time, and their engines were adapted lorry engines. The work was done by hundreds of Africans working with spades, shovels, big knives, and, when we ran short of tools, even with the detached blades of spears. Particularly tough pieces of sudd were severed with ordinary saws, and lilies and floating weeds were cleared with an adaptation of an ordinary garden rake with prongs slightly longer and the last 2 inches curved inwards. The men tied all the tools round their naked waists with rope made of papyrus. This was a very necessary precaution as they were working in water and sudd sometimes armpit deep. Men without tools man-handled great lumps of cut sudd to the sides of the canal and a definite bank was soon formed.

By the beginning of December I had a through canal approximately 15 miles long and almost the requisite 30 feet wide. But it was obvious that along about half its length, from the end of the upper Luapula to beyond where the canoe channel from Kansenga joined (point C), there were several changes of level. The water flowed into the canal at its beginning and ran for some distance, then it ran out again, and then more water ran in again lower down, and constantly along the first 2 miles or so (A–C) there appeared more floating sudd, disturbed from below. I then doubted the native information that the


Kapata
Peninsula
From L. Bangweulu
Papyrus
Papyrus
Kangwena
Lagoon
Luapula River
D
E
F
G
Goodall's Channel (to L. Chad)
First cut, still in use
H
K
L
Upper Luapula
Chibuba
palms
village
villages
A
Kansenga
Sand Spit
Swamp,
mostly papyrus
with small
lagoons
C
Flood Plain
Masombwe
Sketch Map of Outlet
from Lake Bangweulu
Approx. scale of miles
0
1
2
Final channel cut
Abandoned channels
(cut but failures)
Flood Plain
Mukulo
Swamp
and
lagoons
B
Flood Plain
Luapula River
Chambeshi River
Kataba
to Kapalala

Canoes using the Palm Tree cut at Kansenga

Removing a sudd blockage in the Luapula

Barges going through outlet by Mukulo

Digging Palm Tree cut at Kansenga

Luapula had flowed here. Fortunately our difficulties were confined to about the first 2 miles, and I hoped that the floods of the rainy season would scour a permanent channel. In the lower portion of the canal the current was constant and it was obvious that the line there was satisfactory. I tried hard to get a minimum depth of 3 feet throughout.

We stopped work just before Christmas in 1942. The rains were well on and the water rising in the canal made work increasingly difficult.

I came back in March 1943 just before the rains stopped. By then two steel barges were nearly completed on the Copperbelt. Arrangements were being made to buy ten thousand bags of cassava round the lake shores, all to be taken out by the barges through the new canal. It was essential therefore that the outlet should be navigable by about June.

I found my first troubles in the upper Luapula, long before I reached the new canal. The river was blocked, or partially blocked, in at least twelve places. These blockages are formed by small floating papyrus islands that the rising water of the rains break from the lake edge swamp or from the swamps at the southern end of Mbawala island. Some are only tiny clumps, others are a few yards across, and the largest ones have been known to carry an unfortunate sheep. I have seen several with the relics of old fishing huts moving slowly down the river looking rather like primitive house-boats. The current of the upper Luapula rarely moves at more than 2 miles an hour, and when an island moves into the side it is easily stopped. The slight eddy brings, in time, another island and the quick-growing papyrus soon joins up to the papyrus river edge. The blocks formed may stretch across even the widest sections of the river, sometimes 400 yards across, and the depth of the blockage may be as much as 30 or 40 yards. The river flows on underneath them, and since they give fairly easily to the weight of a man it is possible to drag canoes across them. Normally, when the water goes down they are broken from the more permanent bank and villagers hack at them to facilitate their own canoe passage, thus making a clear channel again. This passage is probably not identical with the old river channel and there seems to be no doubt that the hairpin bends and continuous twisting and turning of the upper Luapula, which flows almost entirely through papyrus, are caused for the most part by these seasonal blockages and reopenings.

I put several gangs on to breaking up the obstructions. The usual procedure is to saw and dig at a piece of sudd sometimes as large as 40 or 50 feet square. When that is detached half a dozen or so dug-out canoes push it downstream with their prows forced into the papyrus. It is a skilful art, but the swamp natives, Baunga and Batwa, are more at home in canoes than on dry land, and it is easy for them to push the island into a deep bend in the river and tie it to the bank. Saws are the most useful tool for this work, and a gang of forty or fifty men will clear an obstruction in one day.

When I reached the point where the canal had been commenced the year before, point A, I found the whole stretch A–C completely covered over. It was obviously a high stretch of mud or sudd and no current had gone through it. I was more than ever convinced that this could not be the direct continuation of the Luapula.

I decided to cut into the lagoon close to Kansenga sand spit and follow the dug-out track along the sand spit so joining up with the new canal below Kansenga. I chose what appeared to be, from my amateur calculations, the shortest route through the papyrus. It was at this point that an air photograph would have saved us much expense and worry, for we could have seen at a glance which point on the Luapula was nearest to Kansenga. As it was I was blundering about in floating papyrus over 15 feet high, through which it was impossible to see. However I chose a point just upstream of Goodall's channel and we dug a pilot canal through there. It proved to be about ½ mile long (D–E). But when I began to widen it I found the same trouble with huge lumps of sudd breaking from well below and floating up continuously. I had learned that this meant another higher stretch of sudd, and I hurriedly abandoned that channel. The next place chosen was exactly opposite Goodall's channel, and this stretch (F–G) proved more successful. It was about 800 yards long. At the same time the native canoe route (H–C) past the villages on Kansenga was widened. I knew from experience that there was always some water here, even at the end of the dry season.

The rest of the canal from the silted section to its junction with the natural channel (C–B) was in good order, apart from one blockage. This was right at its southern end and had been formed by the debris of our work floated down by the current. A charcoal-burning boat belonging to the Rhodesia Lakes Trading Company had tried to get into the lake in February 1943 along the new canal but had been stopped by this block. In any case the boat would have been held up by the silted section (A–C) farther on. Incidentally this same boat, owned by an adventurous Lithuanian Jew, had, during the floods of a previous year, actually reached the open lake from lake Chali. The boat had to be poled most of the way and the return journey from Mwamfuli to Kapalala took fourteen days. Later this boat made the same journey through the completed outlet channel in three days.

At this period in the work I was supplied with a Watt's Current Meter which had been tested and rated by the Civil Engineering Laboratory of Cape Town University. There were some corners both above and below the canal that appeared to have a very swift current, and it was essential to find out if the power barges would be able to negotiate them going upstream. But the currents appeared faster than they really were, for at the worst corner, where the current swirled round what was left of a sudd island obstruction, the meter only registered sixty-four revolutions per minute, which is equal to 1·6 miles per hour. These readings were taken in March. At lower water they might have been higher, but it was evident that power barges would have no difficulty with the current.

The lower section of the canal below Kansenga was not as deep as I had hoped it would be, but the currents of the rainy season had kept it moderately clear, and I put on gangs to try and get the specified 3 feet depth throughout. Some sections were naturally much deeper than that. The new cut into Kansenga lagoon (F–G) and the native canoe route (H–C) were proving successful. A minor deviation farther out from Kansenga gave deeper water (H–L), as we discovered by trial, and by the time the diesel barges were ready I had a clear channel right through from the Luapula. So the outlet from

lake Bangweulu was assured. It ran now from F to G alongside the lagoon to H–L and then to C and along the original cut to B, where it joined the natural or old stream. That was the position throughout 1943.

The building of the power units had been delayed and it was August before the first barge came through. This was a steel craft 40 feet long, 8 feet wide, and powered by a diesel engine. She went through empty without much trouble, but going back loaded with meal and towing a smaller steel boat she stuck in many places. The dry season starts towards the end of April and the water in the channel was falling. The draught of the boat when loaded was 2 feet 6 inches and her propeller unfortunately not only lacked protection, but also projected 2 inches below the keel; so for most of the return journey through the channel she had to be poled. She came back from Kapalala towing a second steel barge the same size as herself; while the channel was being deepened these boats were employed on open lake work only, transporting cassava from lake-side depots to Mwamfuli where it was stored. Thus the first power boats had reached lake Bangweulu under their own power.

When the new cut (F–L–C) was completed I found to my great disappointment that the current ran from the lagoon (G) into the Luapula (F). This was not at all what we wanted: we wanted the Luapula to run into the lagoon and so through the channel. However I went on digging and by September the current was reversed and ran from the Luapula into the lagoon and down the channel. It was an interesting example of how delicate the levels are in this area and how even large masses of water can be deviated.

But there were other such incidents later. In October 1943 the Provincial Commissioner, Mr. Gilbert Howe, made a tour of the area, and reported that he found the current had changed. The water from the Luapula was still running from the river into the lagoon along the F–G channel, but at G it was now running to Kang'wena lagoon. This implied that the natural depth of the long Kang'wena lagoon was below that of the outlet and that when the water was at its lowest the channel water was going to the lower level in Kang'wena. In other words, it would appear that our outlet from Bangweulu would function only at high water.

Early in November I traversed the route in a Government motor launch. I had with me Mr. Coleman, who had helped me and who was later to be put in temporary command of the Government Bangweulu fleet. To our surprise we found the current flowing again down the channel from the Kang'wena lagoon. There was no doubt that the change recorded by Mr. Howe had occurred, because Mr. Coleman too had noted it during October. We came to the conclusion that constant digging throughout October and November had again changed the current as it had in the cut from the Luapula (G–F).

Mr. Howe also found that a big area of papyrus between Kansenga and the Luapula had been burned. To the swamp native this plant serves many purposes; out of it he makes string, fish baskets, sleeping-mats, food baskets, cassava drying-mats, roof bindings, doors for his hut, and many other essential items of daily use. The object of the periodic burning is to destroy the old, decayed fronds and so encourage a better growth. The dry stems in such

luxurious growth are naturally comparatively few and the burning is more smouldering and smoke than flame; the somewhat surprising sight of a dense column of white smoke rolling out of an endless area of green swamp is common just before the rains. But if there is also dry grass the few dry stems burn with such a fierceness that they shrivel up the tough growing plants and a continuous section of papyrus may be burnt and withered down to within a few feet of water-level.

Across such a burnt patch Mr. Howe was able to see what had been hidden before: that the clump of borassus palms on Kansenga itself was only about 1400 yards from the Luapula. An air photograph would have shown this at once and have given us a more direct line into Kansenga lagoon than the one we had taken. I wondered why the natives of Kansenga did not use a route across this point, and I was told that this section was higher than the route used and the water got too shallow.

However it was worth while spending some money on a trial cut, and in February 1944 I began the Palm Tree cut (K–L). It is possible to work in papyrus during the high-water season since it floats and to some extent rises with the water-level. A 30-foot wide channel was completed in three months by fifty men and was used by the diesel barges from the middle of April. The only peculiarity about it was that there was a hump in the middle and on one side the current flowed to the Luapula and on the other to Kansenga, but again constant digging destroyed the hump and by May the current was flowing from the Luapula to Kansenga.

The open-water route out of lake Bangweulu is now completed. By the end of the dry season of October 1944, there was a greater depth of water in the channel than there had been the year before and it was flowing regularly and strongly. During the rains of 1943–44 (October–April) a power barge and her towing units transported over three thousand bags of cassava to Kapalala and brought up about 50 tons of goods, including petrol and rice, for Government and private firms, as well as carrying many native passengers (at five shillings each from Kapalala to Mwamfuli) with 100 lb. of luggage free. That was merely the first five months' work. During 1945 a second power barge was obtained and two more steel barges, and the volume of goods and passengers transported increased tremendously. In addition an African put on a power barge and the Rhodesian Lakes Company increased their fleet of charcoal-burning boats. The scheme is a success and the permanent waterway which is now operating will have important repercussions on the future of Northern Rhodesia.

ROUTES OF TRANSHUMANCE ON THE SPANISH MESETA

(*a*) CAÑADAS GANADERAS ESPAÑOLAS. *Congr. do Mundo Portugues, Publicações*, 18 (1940) 682–96, map and bibliography; (*b*) Las Cañadas Ganaderas del Reino de León. *Publicaciones de la Real Sociedad Geográfica*, Serie B, No. 80, 1940; and (*c*) La Cañada Ganadera de La Vizana. *Id.* Serie B, No. 114, 1942. Papers by J. DANTIN CERECEDA

BY THE *cañadas* of these publications are meant the routes across the Spanish meseta used, now or in the past, for the passage of migrant stock—mostly sheep, and commonly called transhumants—travelling between their winter and summer pasture-grounds. Similar routes found in other parts of Spain, usually under other names, are not discussed here, but the stock using them are taken into account in the section on seasonal movements with which this note concludes. In a narrower sense, the term *cañadas* designates those broad tracks on the line of the routes, which lead across cultivated land, connecting the open areas—wastes, commons, and the like—over which the transhumants were free formerly to spread without restriction. In an extended sense, the word cañadas, like the word "railway" in Great Western Railway, refers to the whole system of routes leading southwards from each of the principal *sierras* or *quadrillas* of the north.

Originating presumably in rights of way established by early custom, the cañadas in the narrower sense appear already in a Royal Charter of 1284 with their full legal width of "seys sogas de marco de cada quarenta y cinco palmos la soga" (Brit. Mus. 765 h7, fol. 49 rev.), the equivalent of 90 *varas* (Castilian yards) or 75·22 m.[1]

It will be obvious that rights of way on this scale and in number sufficient to carry, in the peak year of the traffic, more than three million sheep over distances of 100–450 miles each way, could only be maintained at a certain stage of the country's development. While they were maintained, the cañadas were not so much routes as "elongated pastures," along which, in the sixteenth century, ebbed and flowed "the broad tide of the country's greatest single resource," the fine wool of the transhumant merino sheep (*1*, pp. 90 and 223, see references, p. 68).

With the decline in the relative importance of the fine wool, the interest of the central government in the protection of the cañadas waned; the office of the itinerant magistrate with direct jurisdiction in cases of encroachment was abolished in 1796, and the corporation (*Mesta*) of owners of transhumant stock, with its special tribunal, disappeared in 1835–36, transhumant interests being merged with those of stock-owners in general under the newly formed *Asociación General de Ganaderos del Reino*. So far as the cañadas are concerned, this Association, with the inherited archives of the Mesta and a rich collection of reports from its own Visitors, has been from 1836 until recently (1944) the authoritative source of information and, during a great part of this period, representing the State itself as guardian of property belonging to the public demesne,[2] it had the duty to initiate any action needed for the protection of the cañadas.

[1] The writer does not know how this result, which implies a *palmo* of one Castilian foot, is arrived at, but the equivalents given appear in later legislation.

[2] The cañadas are first described specifically as "royal" in a Charter of 1462, but the Preamble to the Decree of 1924 sets forth that the Fuero Real (1254) had vested in the King the property in stock roads of every class.

But the cañadas were not fully open when the Association took them over; the interest of the stock-owners in keeping them open has been uneven; and a far-reaching conflict of interests in questions of encroachment has made it easy to obstruct protective action at different levels. For these reasons the divergence between their situation in law, which remains unchanged throughout not being subject to prescription, and their situation in fact, had become very wide by 1924, when the Government of the Military Directory made the first proposal for a definitive settlement (*2*, pp. 3,ff.). The problem was much too large however for the summary treatment proposed, and at the close of the Civil War it subsisted in a much aggravated form. In recent times the special service under the Ministry of Agriculture, *Servicio de Vías Pecuarias*, to which has passed the entire responsibility for the cañadas, has been charged with the task of effecting, by annual stages, a settlement on terms laid down in the decree of 23 December 1944 (*3*), which resemble in principle those of the 1924 decree. The cañadas are to be classified into "necessary," "unnecessary," and "excessive" (that is, wider than need be); the "necessary" are to be marked off definitively; and the land no longer required for the others is to be sold for the benefit of the parishes concerned and to meet the expenses of the Service. For our purposes these decrees are of interest mainly as recognizing in so many words the desuetude into which many of the cañadas have fallen, and as evidence of the living interest of the stock-owners in maintaining the others.

No general map of the cañadas has ever appeared under the direct auspices either of the Mesta or of the Association, although, in 1718, some steps were taken towards the appointment of a special cosmographer for this purpose (*4*, pp. 27 f.), and, in the nineteenth century, much of the preliminary work for such a map was carried through by the Association and two sectional maps actually appeared (see below, p. 61). But, in 1910, Fribourg, without reference to the Association, published a map (*5*, Pl. XIVa), under the title "Anciennes routes de transhumance en Espagne," based merely on the reports for 1891 made by the provincial officers of the *Servicio Agronómico*. In the map following (Pl. XIVb) he showed the routes by rail which had, in his view, largely superseded the routes by road at the beginning of this century, and the "anciennes" of the title refers in the first place to this change. The map may however have been understood by readers as an adequate representation of the historic routes. That it could not be that became evident in 1920, when Klein published incidentally, in the course of an economic study of the Mesta, a map of the "cañada routes" (*1*, following p. 18), exceedingly unlike Fribourg's corresponding map, which he described as "evidently from eighteenth- and early nineteenth-century materials" (*1*, p. 19, note 3). Since the sources quoted for Klein's map were, with one exception, of fourteenth-century date, the inference, drawn with some misgivings, appeared to be that there had been, at a relatively late date, when new rights of way were less likely to have been established, an abrupt change from an old to a later system of roads; but both systems had passed virtually into history, since Klein endorsed Fribourg's view of the modern use of the railway—"Most of these [the 'transhumantes'] no longer follow their old cañadas, which have largely been enclosed. Instead they use special types of . . . railway cars" (*1*, pp. 348 f.).

And so the matter remained until Dantín Cereceda, in the three papers under review, re-opened in effect the whole question of the cañadas, although it was only in respect of the Leonese cañadas that he challenged specifically the work of his predecessors. Unlike Fribourg, Dantín has gone for his material to fountain-head, in the Library of the Association, using, in the first place, a series of pamphlets containing detailed descriptions of the cañadas, written by

BAY OF BISCAY
Santander
Miles
20 0 20 40 60 80
Routes defined approx.
Major toll point
Minor toll point
Bridge or ferry
Mountain pass
Change of tint at every 500 metres
CANTABRIAN MOUNTAINS
Buron
Cervera
Aguilar
Inicio
Lorenzana
LEON
Burgos
R. Ebro
Puente de la Vizana
Palencia
Castrogonzalo
Agreda
SORIA
Vinuesa
Villanubla
Valladolid
Toro
Aranda
Langa
Tudela
Almazan
Zamora
Carabias
Berlanga
Santa Maria de Riazza
Coca
Alcuneza
Ledesma
Salamanca
SEGOVIA
Las Inviernas
Alba
CAMPO AZALVARO
Avila
El Escorial
MADRID
Ciudad Rodrigo
Beteta
Bejar
Cebreros
Ambite
Tragacete
SIERRA DE GREDOS
Escalona
Fuentiduena
CUENCA
Malpartida
Talavera
Uclés
Candeleda
Berrocalejo
El Puente
Toledo
Sinarcas
Almaraz
Trujillo
Alia
Queron
Alcazar de S. Juan
Villarta
Jorquera
Peloche
Santa Amalia
Merida
Esparragosa
Alcolea
Manzanares
Chinchilla
LA SERENA
Veredas
Campo de Calatrava
Campo de Montiel
Cabeza del Bucy
Torrecampo
VALLE DE LA ALCUDIA
Montemolin
Villaharta
Linares
Santisteban del Puerto
SIERRA MORENA
Cordoba
Fernan Nuñez
Lorca
Ecija
Sevilla
Granada
Malaga
MEDITERRANEAN SEA

Fig. 1

Visitadores Estraordinarios after special journeys of reconnaissance made in the years 1852–54, with two maps resulting from independent surveys made a few years later, and drawing for his annotations on manuscript material from the Association's archives "to date."

The pamphlets, which are cited below under the numbers P1–P9, appear as follows in the R.G.S. catalogue, the order of numeration following the traditional order of the quadrillas served, and differing from that adopted by Dantín:

1. 'Descripcion de la Cañada Soriana,' 1857.
2. 'Descripcion de los Ramales de la Cañada Soriana desde Villacañas y Quero al Valle de la Alcudia,' with Appendix (pp. 37 ff.), 'Descripcion de la Cañada Real de la Provincia de Córdoba,' 1858.
3. 'Relacion Descriptiva de los Principales Caminos Pastoriles de la Provincia de Cuenca,' 1883. (MS. summary only.)
4. 'Descripcion de las Cañadas de Cuenca,' 1860. (Continues No. 3.)
5. 'Cañada Occidental de la Provincia de Soria,' 1856.
6. 'Descripcion de la Cañada Segoviana,' 1856.
7. 'Descripcion de la Cañada Leonesa,' 1856.
8. 'Cañada Léonesa desde El Espinar a Valdeburon,' ? *c.* 1860. (Map showing northern half of cañada described in No. 7.)
9. 'Cañada de La Vizana y parte del Cordel de Babia de Abajo.' (Map only, ascribed by Dantín on internal evidence to *c.* 1866.)

The importance to the historical geographer of this body of first-hand material hardly needs to be stressed, and Dantín, to whose memory this note is intended as a respectful tribute, performed a signal service in introducing it to a world public in the rapid summary of his paper presented at Oporto. He himself illustrated the summary by a map (a, p. 11), but this seems unduly skeletal and a map making fuller, but still not exhaustive, use of the material has been prepared (Fig. 1) to assist the work of reconciliation with other maps. The Visitors, in following persistently trunk routes, to the exclusion of cross-routes and branches indicated but not fully described, performed a work of selection and generalization appropriate to their period,[1] but clues to the relations between this work and the similar work of other periods are often to be picked up in the routes left undescribed.

In Fig. 1, pecked lines show roads described in the pamphlets, usually in minute detail, but at least in detail sufficient to fix the line on this scale. Dotted lines show roads indicated in more general terms, and arrow-heads are used to show the general direction followed by feeders and continuations. These are the only distinctions drawn, but, with very few exceptions, all the roads shown are of full cañada status. There is evidence for the existence of both of the roads marked with a ? in Fig. 1, connecting the "Soriana" with the Cuenca system, and both were probably, though not certainly, indicated in the pamphlets.

Thus we have three maps of the cañadas in the field: Klein's (K), Fribourg's (F), and a map based on the pamphlets (P), to which Fig. 1 is a close approximation, and the object of this note is to suggest the contribution which may be expected from each towards the composite general map which seems to be all that can be hoped for at present. (Whatever the objections to such a map,

[1] This will be appreciated more fully if P5, compiled from the archives without reconnaissance, is compared with the other pamphlets. The data of P5 are represented in Fig. 1 by a purely schematic arrangement of routes fanning out from Vinuesa to the Douro and Riaza bridges.

it would be much less misleading, for the last four centuries, say, than any of the individual maps taken separately.)

Besides these three maps, a fourth, of date 1944 (*6*, Fig. 1, facing p. 8) and a fifth, a *Mapa Pecuario* of the *Ministerio de Fomento* bearing the date 1925, have recently reached the R.G.S., but the 1944 map (A) is obviously a reproduction of a later edition of the 1925 map (M.P.), of which the topographical basis and method of construction are more suited to a diagram than a map. Both are accordingly regarded here as subsidiary to P; they belong clearly to the same "family" as P, deriving beyond doubt from material supplied by the Association, which has always been in closer touch with the livestock departments of the responsible ministry than with the agronomic.

To supply the basis for the suggested composite map, P seems more suitable than either F or K. It is unlikely that the lines shown in F were controlled so thoroughly as those of P. K is unsuitable, partly because of its diagrammatic character (coordinates cannot safely be measured from it), partly because the general picture it gives is of too early conditions; it does not even illustrate fully Klein's text, omitting, for example, "the line of the much-travelled Sorian cañada" passing Guadalajara (*1*, p. 213, with reference to 1485), and, for that reason, failing to account satisfactorily for the toll-points shown at Alcázar de San Juan and Villaharta (in the position of the map: see below). P has, for its own period, some serious defects of omission which could be remedied by grafting on material derived from other sources; Fig. 1 however shows material derived from the pamphlets only.

Space does not permit a detailed comparison of F, K, and P, but a brief consideration of two special cases, that of the "Cañada de La Vizana" of P_9, and the provision made by the three maps respectively for the Sorian sheep, may suffice to bring out their characters. Before entering on this, three principles of critical appreciation should be stated.

First, the ambiguity of the word "cañada," explained in the opening paragraph, must always be borne in mind. The use of cañada in the extended sense, denoting a system, may be expected at any period. In the pamphlets it is used in this extended sense perhaps only in the title of P_5, but the loose usage of the word in the other senses is most instructive and should, in itself, rule out any argument based on nomenclature. Thus P6, 'Descripcion de la Cañada Segoviana,' describes a route which is called in the text itself "cañada real de Burgos" (pp. 4, 7) and "cañada de Burgos y Soria" (p. 23), while "cañada segoviana" is applied in the text of P_7, 'Descripcion de la Cañada Leonesa,' to the second part of the route described—southwards, that is, from the Campo Azálvaro, the great resting-place of the transhumants on the high plain to north of the Sierra de Malagón. The Visitors, in other words, were not consistent in stamping their own general name on a trunk route each section of which had commonly its own local name noted in the description. At least, they distinguish correctly the cross-routes and branches, three of which are shown as specimens under their individual names in the map (Fig. 1), the Cañada de la Legua, Cañada de la Vera de la Sierra, and Cordel de los Sorianos.

Secondly, it is useful in examining a map to note how many of the great winter and summer pasture-grounds are served by the routes shown, and, in particular, how many pairs of these are in easy communication with each other.

Thirdly, the acid test for a map adequate for the purposes of Historical Geography is that it shall account for the positions of the Toll Points (*puertos reales*) at which the royal taxes (*servicio y montazgo*) were collected. Until these taxes were abolished in 1758 transhumants were defined in law with reference to the

obligation to pass through one of these points. Fifteen Toll Points are shown in K, but the seven major points, passing about 75 per cent. of the transhumants in 1477 (*1*, p. 272, note 1), were in order as follows: *1* Venta del Cojo, *2* Villaharta, *3* Torre de Esteban Ambran, *4* Socuéllamos, *5* La Puebla de Montalbán, *6* Rama Castañas, *7* Abadía. They are shown under these numbers in Fig. 1. Villaharta is shown in K in the position of Villarta, south-west of Alcázar de San Juan (Ciudad Real), but the reference in Klein's text (*1*, p. 276, note 5) seems more appropriate to Villaharta (Córdoba) on the road from Córdoba to Almadén.

Venta del Cojo and Torre de Esteban Ambran commanded respectively the routes of the Upper and Lower Alberche; Socuéllamos, on the edge of the saline lagoon area of La Mancha, was a point of convergence for routes from the highlands of Cuenca; Montalbán watched the principal crossing of the Tagus; Rama Castañas, the exit from the Sierra de Gredos by the Puerto del Pico; and Abadía, the historic pass of the Puerto de Baños (Béjar). The eight minor points were, in order from west to east, Puerto de Pedrosin, Malpartida, Albala, Berrocalejo*, Candeleda, Puente del Arzobispo*, Alcázar de San Juan*, and Chinchilla*. Of the fifteen points, eleven date from 1457[1]; the other four, marked by an asterisk above, are of later date. The positions of the minor points are marked by circles in Fig. 1, with the exception of Puerto de Pedrosin and Albala. These names are unknown to the writer, but Pedrosin must have been at the pass of Perales, in the Sierra de Gata, north of Moraleja, a pass used by Beresford in 1809, and still crossed by a "cañada real" in 1917 (7, I, p. 317). Albala may be assumed to have been at, or near, the position of the Puente del Cardenal.

Klein says that "the last year of the servicio (1758) found the list [of toll points named in 1457] only slightly changed" (*1*, p. 266), but this is hardly borne out by his later statement (*ibid.*, p. 292, note 4) that the royal tolls were being collected at that time at three points only, Entrada de la Serena, and two others not identifiable. P7 (p. 33) gives the exact position of the first, at Esparragosa de Lares, calling it a *contadero*, and it is marked C in Fig. 1. The others may conceivably have been at the *sitio del contador*, south of the crossing of the R. Matachel, on the next cañada to the west (P7, p. 46), and at the *contadero* in the parish of El Moral de Calatrava (P4, p. 11), but this is purely speculative. The limits of date within which the acid test mentioned above is valid cannot therefore be stated precisely; it remains true nevertheless that, whatever these are, a satisfactory general map of the cañadas must account for each of the fifteen points. The converse test is not, however, valid: it must not be assumed that a road unrelated to any of the fifteen toll points cannot have been used at an early date by seasonal migrants. Besides the transhumants, these included, certainly from 1480 (Brit. Mus. 765 h1, No. 1, *passim*), migrants of shorter range, *transterminantes*, *riberiegos*, or *travesios*, defined as passing beyond the border (*ribera*) of their native parish (*término*) and subject to a different tax (*travesío*) collected at different points. Before leaving the subject of the toll points it is desirable to remind the reader that Klein, whose evidence here is invaluable, cannot fairly be pressed too hard on geographical matters which were merely incidental to his economic study.

Let us now consider the particular case of the "Cañada de La Vizana" which was the basis of Dantín's criticism of Klein and Fribourg. As applied to a cañada, the name is peculiar to the pamphlets, appearing in the title of P9, which gives a map only, for which Dantín has supplied a text with valuable

[1] Two other points on the 1457 list are not shown either in K or in Fig. 1. They were at Aldeanueva de la Vera, west of Jarandilla (Cáceres), and at Perdiquera or Perdiguera, in the parish of Consuegra (Toledo) on the western branch of the Soriana (P2, p. 5).

annotations (*b*, pp. 4–26, and *c*, *in toto*).[1] The cañada proper connects the summer pastures of the upper Orbigo north of Inicio with the winter pastures of Trujillo, taking its name from the Puente Vizana by which the middle Orbigo is crossed near Alija, on the southern boundary of León, but a feeder (*cordel*) by which sheep come down to it from the high pastures (*puertos*)[2] of the Babia district round the head-waters of the Luna appears in the full title of P9, indicating that at that time the route was conceived of primarily as a route from Babia to Extremadura.

Dantín's criticism of Fribourg and Klein was that they had confused "La Vizana" with the "Leonesa" (of P7 and P8, that is), the gravity of the error being heightened by the primordial importance of Babia at the northern terminal of La Vizana and by the position of Béjar, a town on the route, as the chief centre of the woollen industry on the Meseta. Now K need not be taken to conflict so hopelessly with P as Dantín supposed. K does in fact show the greater part of La Vizana, from the Esla crossing at Castrogonzalo to the Tagus crossing at Albala, in the trunk route of Klein's "Leonesa system," and a line which is nearly the line of the "Leonesa" of the pamphlets, from the Carrión valley to the neighbourhood of Segovia, in one of the trunk routes of his "central system." There is therefore a presumption that the apparent confusion may be a mere matter of nomenclature, and this is hardened when we note (*b*, p. 38, note 22) that "La Vizana," in the neighbourhood of Puente Vizana itself and elsewhere, is known locally as the "Cañada Real Coruñesa" (as if its main objective were the pastures along the high road to La Coruña by the pass of Manzanal and the Vierzo), and see what is substantially the same cañada marked in the map of 1944, A, "Cañada Real Zamorana." (The moral is clear, that our hypothetical map of The Cañadas through the Centuries had better avoid labels.) F, too, shows a considerable stretch of the line of La Vizana or of its branches, but connects it with the western rim of the Vierzo, giving point tacitly to the local name mentioned above.

With regard to Babia and Béjar: the intimacy of their connection with "La Vizana" may easily be exaggerated. K shows a feeder from Babia—apparently, but the scale is small—which took the sheep down to join the main cañada at the city of León, and the sharp bend by which the *cordel* joins the main cañada in P suggests a later diversion from such a route. During the Peninsular War Babia improved in standing (*8*, p. 119); the provincial headquarters of the *departamento* which succeeded to the *quadrilla* of León were established in "Las Babias" (*4*, p. 69), not in the capital itself; the title of P9 may well reflect a degree of intimacy peculiar to the nineteenth century. – Béjar does not appear as a manufacturing centre until the eighteenth century; it stood on or near more than one cañada (see K); and it had considerable local flocks to draw on for any fine wool it may have used. Its improved standing from 1791 (*b*, p. 22, note 13) was perhaps a tribute to the importance of these local flocks rather than of "La Vizana."

Taking now the question of the summer pastures served by the routes of the three maps: the need for a composite map, and for one drawing on all available sources for its material, is at once obvious when we see that the Leitariegos and Vierzo pastures are provided with routes in F only; the Sanabrian pastures in

[1] The student should add to these by a reference to R. Stickel, "Observaciones de morfología glaciar en el NO de España," *Bol. R. Soc. Esp. Hist. Nat.*, 29 (1929) 303, with Pl. 23, Figs. 1 and 2, and Pl. 24, Fig. 1, where a highly relevant description is given of the neighbourhood of the terminal point.

[2] Note that, in this context, *puerto* has the three senses, of a pass, a high pasture not necessarily connected with any pass, and a toll-point.

P only;[1] and the Pajares pastures in none of the three, although Joseph Townsend, descending from the pass towards León in October 1786, overtook a Guadalupe flock moving southwards (*9*, II, p. 61), and the transhumants in this sector of the Cantabrians numbered, in 1891, between thirty and fifty thousand (F).

Finally, with regard to toll-points, F gives added point to Malpartida as watching the road from the pass of Tornavacas, but fails completely with Abadía. Incidentally, the *ingeniero agrónomo* reporting for Cáceres in 1917, agrees with his predecessor of 1891 in omitting mention of any cañada crossing the pass of Baños, as if the old cañada here had gone out of use. Yet it is claimed in A. However that be, the fundamental fact remains that K and P agree in bringing over the pass and through Abadía a major cañada, under whatever name, which follows more or less closely the line of the Roman road from Salamanca—"La Vizana" is in fact already on the actual line of the road a few miles to the south-east of Astorga, where it is known as the "Calzada de los Gallegos." The line across the pass may be presumed to have been used by the Salamanca transhumants who were the subject of sixteen articles of the fourteenth-century *Fuero* of Salamanca.

The second case which we consider, that of the respective routes provided for the Sorian sheep, justifies the claim made above that P is the best of the three maps to take as basis for a composite map. Neither of the others offers so rich a choice of winter pastures to the Sorian flockmaster, or shows the full importance of the Valle de la Alcudia as a pasture-ground common to the sheep of all four quadrillas. F connects Soria by a single cañada with La Mancha only, as far as the R. Jabalón. K does not connect Soria at all with La Mancha, which is the preserve of the Cuenca sheep, but brings it into Klein's central system, with a trunk route running along the southern front of the Guadarrama and distributing sheep to Extremadura, the Guadalquivir valley, and the Alcudia approached from the west. But K shows, what no other map shows, a circuitous route from Soria, by the northern branch of the central system, to the Alcántara pastures of the Tagus valley. P shows both an independent system, the "Cañada Soriana" proper (P1, P2, and P4), and a series of routes—the so-called "Western" cañada (P5)—which become merged, as the branches of the "Soriana" are, in the Segovian and Leonese systems.

The trunk route of the "Soriana" proper runs direct to the saline lagoon area of La Mancha, combining at Manzanares with the trunk route from Cuenca to form the joint "Cañada de Soria y Cuenca" (P4), which proceeds towards the main objective, the Valle de la Alcudia, throwing off branches by the way to the Fresnedas and the Calatrava pastures. Near the entrance to the great vale, sheep from León and Segovia join the Sorian and Cuenca sheep, and the cañadas are merged in a single track (*vereda*) 300–400 yards (Spanish) in width. Beyond the vale, a cañada used mainly by the Sorian sheep and therefore described in an appendix to P2 leads to Córdoba and the Guadalquivir valley.

The relative importance of this trunk route was probably much greater after the Peninsular War, when the Sorian flockmasters had difficulty in finding pastures in Extremadura (*8*, pp. 12, 40, 118, 125). In 1912, only Sorian transhumants visited the pastures of Córdoba (*10*, p. 298), and the cañada of the appendix is marked in A "Cañada Real Soriana" (and extended, incidentally, to join, below Seville, the extension of the cañadas of the west, which reaches ultimately the Campo de Gibraltar).

[1] Dantín's note (*6*, pp. 13 f., note 8) on the Sanabrian cañada (Porto to Benavente), of which the terminal only is shown in P9, has been, by exception, taken into account in preparing Fig. 1.

To the winter pasture-grounds of Extremadura and the south, the rich provision of routes offered by P can be appreciated fully in Fig. 1. One of these routes, which branches from the "Soriana" at Soria itself, has the standing of an alternative trunk route, running along the northern margin (*vera*) of the Guadarrama as the "Cañada de la Vera de la Sierra" to Campo Azálvaro, where it becomes, rather than is merged into, the "Segoviana" of the second part of P7. A does not show either this, or any other, branch of the "Soriana," so that F may be more faithful here than P to the modern fact. In its day, which lasted probably until the Campo Azálvaro was broken up in the latter half of last century, this branch was the functional equivalent of the southern branch of the central system of K, represented in P only by a residual which will not escape the keen-eyed student.[1]

Turning now to review the maps as a whole, we note that P accounts for the position of all the major toll-points but one, Rama Castañas, including both positions of Villaharta, and of all the minor points but three, Pedrosín, Candeleda, and Chinchilla. F certainly fails with Abadía, Pedrosín, Candeleda, Albala, Puente del Arzobispo, and Chinchilla, and is not very convincing in respect of one or two of the others, failures which will only surprise any one who persists in regarding F as being in itself a map for the historical geographer. Since nodal points make good toll-points, it need not cause surprise if F or P is found, as sometimes happens, to put a particular toll on a different road from K. In such cases it will usually be found that K does not, by itself, fully account for the toll-point. Torre de Esteban Ambran (*3*), for example, stands, in K on a clear road connecting *1* and *5*, but in P on a cross-road, the "Cañada de Escalona," [2] whose existence might have been inferred from K, as otherwise the toll-point has no *raison d'être*. The road from Tornavacas, shown in F, might have been inferred similarly from the toll at Malpartida, and there is *a priori* a presumption that a road from the north to Alcántara, by Ciudad Rodrigo and Moraleja, existed to account for the toll at Pedrosín.

The failure of P to account for Rama Castañas and Candeleda points to its most serious defect, that it leaves in blank the greater part of the province of Avila. Both the northern and southern branches of the central system of K crossed Avila, and F shows still a third-class road on the line of the northern branch from Avila to El Barco by the Corneja valley.[3] On the line of the southern branch, which used the Upper Alberche valley, there was still in 1846 a cañada "coming down by the Puerto del Pico to the bridges of Almaraz and Merida" (*4*, p. 30), with which the "Cordel de la Morcuera", left in the air south of El Escorial, may well have been connected, and a truncated section appears still in A. The longitudinal valleys of the Corneja and upper Alberche are among the richest in pasturage of the province (*7*, I, pp. 210 f.), and it is intelligible that the sheep, which at one time used them freely, should later have been confined in the main to transverse lines. Candeleda is cut out because the pass above it is not lower than 2000 metres and it is not readily accessible by a transverse line from the north; the Puerto del Pico (1352 metres) and Puerto de Mijares are

[1] The "Cordel de la Morcuera," which combines part of the old branch route from Segovia by the Puerto Morcuera with a fragment of the old trunk route cutting the "Segoviana" south of Buitrago. (P6, pp. 13, 16, and P7, p. 50.)

[2] Imperfectly described in the pamphlets. Sheep using it passed through the heart of Madrid by the Puerta del Sol on their return journey in spring (*4*, pp. 30, 32, and *1*, p. 312, note 1).

[3] Here Townsend, travelling up from Piedrahita in October 1786, "overtook several Merino flocks returning to the south" (*9*, II, p. 97—the direction of the movement is surprising).

lower, and one or other is used by the road from Leitariegos shown in F. (The road south across the Mijares from the bridge at Burgo-hondo dates at least from 1480, when a sheep-tax, probably the travesío, was levied at "el puerto Hondo, con los mijares" *Brit. Mus.*, 765, h1, No. 1, p. 8.) A road of some importance, not noted in any of the maps, seems to be needed to explain Manuel del Río's reference to head shepherds who join their flocks at Peñaranda (between Salamanca and Avila, *3*, p. 41).

The deficiency of P in the north-east section, where the province of Burgos is equally shown in blank, cannot be discussed here. K and F supply some material which seems inadequate to the writer; A gives no help whatever. In the south-east no map except K connects the Meseta with Murcia, by Chinchilla or otherwise; F shows Chinchilla standing on a route belonging to a "Mediterranean system." Towards the east, M.P., but not A, agrees with F in continuing two of the Cuenca routes to the rice-fields of the Albufera, where, in fact, about the date of M.P., twelve thousand transhumant sheep were reported as wintering (Sölch, "Die Landschaft von Valencia," *Geogr. Zeitschr.* 32 (1926) 347).

To sum up, the immediate impression made by K of being an utterly different map from the other four mentioned here will be found on examination to be due to the predominance of the longitudinal line, suggesting on the whole leisurely movement from north-east to south-west which reflects the easier age of the "elongated pastures," when the north-east counted for more than it did later, and Soria was indeed "head of Extremadura" (*Soria pura, cabeza de Extremadura*). The student who notes how much of K is still to be found in P and F, and who reflects that what is in F, but not in P, could not have arisen *de novo* in the forty years' interval separating them, will perhaps agree that the old dies hard, and that the "new" is merely that which has emerged from obscurity. Which puts succinctly the case for a composite map.

Before concluding, the writer takes this opportunity to express his gratitude to the late Sr. D. José López Pérez y Fernández, of the staff of the *Asociación General de Ganaderos*, and, more particularly, to Dr. A. R. Pastor, formerly of King's College, London, and his correspondents in Spain, for invaluable help given in this context, in 1923 and again more recently.

Note on recent seasonal movements

A short note is added to amend the setting provided for the question of the cañadas by Fribourg's article (*5*).

Transport by rail was not adopted so widely on the Meseta as Fribourg supposed, or anticipated. Outside the Meseta the question of road versus rail has never been a living question. Towards the end of the 1920's, flocks were still travelling by road, all the way, from the north-east to Extremadura, Andalusia, and the Alcudia; even to-day, the long march by road is still favoured in principle by many flockmasters (*6*, p. 12). But the net effect of the Civil War has been to increase transport by rail (private letter from the *Ministerio de Agricultura*).

The 1912 report (*10*) lends no support whatever to Fribourg's statement that the general direction of transhumant movements—on the Meseta, that is, though he does not say so explicitly—had been completely changed. In summer, León and Zamora were by far the largest receiving provinces, the visiting sheep (565,000) coming entirely from Extremadura and the basin of Old Castille, especially Salamanca, a movement from south to north. In winter, Ciudad Real (principally the Alcudia) was the largest receiving province, the visitors (166,000) coming from Segovia and the north-east. The two provinces of Extremadura received in all 265,000 visitors from provinces lying to north

and north-east of them as far as Burgos, with some sheep from Soria. Except that a few sheep moved from Avila for the winter to the eastern Sierra Morena (Jaén), there was no indication of a movement which might not have been made by the roads of the three maps. Avila, moreover, which is not itself a receiving province at any season, is specifically said to give "safe lodging" to passing transhumants (*10*, p. 86).

Under Valladolid however "a fair number of sheep and goats" are mentioned (*10*, p. 68) coming to the stubble pastures in spring from Soria and Salamanca, and the Sorian stock may well have travelled by the Ariza–Valladolid cross-country railway. This movement, of which Fribourg made too much (*5*, p. 240), is analogous to the short, interprovincial movements to stubble and other pastures, made in the south, and now apparently increasing there, to tide over the summer season of shortage (*7*, I, p. 260, and *6*, p. 26). They have not been reckoned as transhumant movements, but a modern definition of transhumance might cover them.

The total of transhumant sheep, mostly merinos, visiting the provinces of the Meseta in 1912 was 1,204,000, but the double transhumants of Salamanca must have been reckoned twice, and the total includes sheep both from Teruel and from Aragon beyond the Meseta (*7*, II, p. 451, says "Huesca"). (For the *cabañeras* linking with the cañada system of Molina, by which the Huesca sheep could have travelled, see F and *7*, I, p. 434.) Under Cáceres, moreover, an unspecified number of swine visiting the winter acorn pastures were included with the sheep.

Transhumance "tends to diminish" at present (private letter as above); nevertheless, Santos Arán estimates at a round million or rather more the number of transhumant merinos (*6*, p. 36). Broadly speaking, transhumance on the Meseta may be considered to be back on the 1912 mark, but still, of course, a long way ahead of the half-million mark of the mid-nineteenth century (*1*, p. 348).

Except for Teruel, Aragon has no merinos, and its own fine-woolled breeds are not transhumant. The great majority of its seasonal migrants are sheep, but transhumants and transterminants cannot be sorted out in the statistics, a new uniform criterion being in any case necessary for comparing Aragon with Castille. In east and south Spain, seasonal migrations are relatively negligible. In 1912, Alicante received only one thousand sheep and goats from outside the province, in spite of the facilities marked by the thick red line connecting Zamora and Alicante in Fribourg's railway map. The great five-year drought of 1908–12 had something to do with this, no doubt; but the drought was raging when Fribourg wrote. In north Spain, sheep are in a minority, and transterminants in a very large majority, among seasonal migrants.

For the purposes of a general comparison, one may say, very roughly, that, in 1912, the seasonal migrants of the Meseta were twice as numerous as those of the north-east (Navarre, Aragon, and Catalonia), and four times as numerous as those of the rest of Spain put together. Also, that between 7 and 8 per cent. of the whole livestock of the country were seasonal migrants making journeys of some distance beyond the limits of their home parishes. ROBERT AITKEN

REFERENCES

(1) J. Klein, 'The Mesta, a study in Spanish economic history, 1273–1836.' Harvard Economic Studies, 21, 1920.
(2) "Disposiciones oficiales para la clasificación y deslinde de vías pecuarias," 1927 (with legislation, 1924–27).
(3) "Reglamento de vías pecuarias," 1944 (giving the present code).

(4) "Memoria sobre el estado de la administracion y legislacion de las cañadas: presentada . . . en el Año de 1846," 1881 (with résumé of all earlier legislation).
(5) A Fribourg, "La transhumance en Espagne," *Ann. Geogr.* 19 (1910) 231–244; pls. xiva and xivb.
(6) Santos Arán, 'La producción de ganado Merino en España,' 1944.
(7) 'Estudio de la Ganadería en España. Resumen . . . de las Memorias de 1917,' 2 vols., 1920.
(8) Manuel del Río, 'Vida Pastoril,' 1828.
(9) J. Townsend, 'Journey through Spain in the years 1786 and 1787,' 3 vols., 1792.
(10) 'Avance estadístico . . . pastos, prados, etc. Resumen . . . de las Memorias de 1912,' 1914.
(11) 'Reglamento de la Asociación General de Ganaderos,' 1920 (with legislation affecting the cañadas, 1892–1917).

Note: With the exception of (1) and (9) copies of all these publications are in the Library of the Society.

A NEW MANUAL OF OCEANOGRAPHY

THE OCEANS: their physics, chemistry, and general biology. By H. U. SVERDRUP, MARTIN W. JOHNSON, and RICHARD H. FLEMING. *London: George Allen and Unwin*, 1944. (*New York: Prentice-Hall*, 1942.) 9×6½ *inches;* x+1088 *pages; illustrations, diagrams, and maps.* 63*s*

ALTHOUGH PHYSICS, chemistry, biology, and geology are closely associated in many basic problems of the sea, their applications are generally studied by specialists who do not have sufficient time to follow the rapid developments in more than one branch. One of the chief difficulties has been the lack of a comprehensive manual, and Sverdrup, Johnson, and Fleming have done oceanographers a great service by writing 'The oceans,' a complete work useful to specialist and beginner alike. It was published three years ago in the United States, but its circulation to this country has been restricted until last year.

The Scripps Institution of Oceanography, where it was written, is a department of the University of California, founded and equipped with liberal help from the Scripps family. Dr. Sverdrup, well known for his oceanographical and meteorological work in the *Maud* and at the Geophysical Institute in Bergen, has been the director since 1936, and Johnson and Fleming are assistant professors. All branches of oceanography are actively pursued there, and the authors express their indebtedness to their colleagues who helped to make the book. Those who have visited the Institution will recognize the book as an excellent tribute to the cooperation that prevails there.

The wealth of detail and abundant references emphasize the growth and refinement of oceanography during the past twenty years. There is still scope for exploring expeditions to chart the physical characteristics, marine sediments, and the ocean bottom, but the golden opportunities for descriptive work are past. A research vessel must now have laboratories almost as well equipped as those on shore if she is to go far afield; and the oceanographer has little hope of making any great advance unless his spirit of adventure is supplemented by a thorough scientific training, a capability for accurate work under tiresome conditions, and a careful study of previous data and relevant literature.

The authors attribute the rapid developments of the past twenty years to refinement of the methods of study, and to the application of the results of theoretical studies and laboratory experiments; but their insistence, in every part of the book, on the need for more observations shows that theory and hypothesis have often outstripped the work at sea. The book will help in the organization of future expeditions; its full survey of existing knowledge and comprehensive bibliographies will assist in planning the work; and the capable summary of accumulated experience in design of research vessel, methods, equipment, and other facilities will help in carrying it out.

In their description of the oceans and physical features the authors have used the terminology and nomenclature favoured by most members of the committee of the International Association of Physical Oceanography, appointed to discuss them in 1936, and they emphasize the need for further classification. There is little doubt that the new term Seamount, for a mountain-like structure rising from the ocean bottom, must be accepted; but it is a relief to find that the authors do not use Swell, as seen in United States publications before the war, for a long broad elevation rising gently from the bottom. It is doubtful whether any useful purpose is served by the names Arctic Mediterranean, American Mediterranean, and European Mediterranean; oceanographers need no reminder of the semi-enclosed nature of these seas, and they will not replace the names in general use.

It is almost impossible to avoid the existing confusion in nomenclature. Algiers–Provençal Basin on page 643 is used synonymously with Balearic Sea on page 649; the Cayman Basin II on page 35 is called Yucatan Basin on page 639; and North Polar Sea, Arctic Sea, and Polar Sea, all mean the same on page 658. Possibly because of the objection of the U.S. Hydrographic Office to the name Southern Ocean the authors have not used it; but it is interesting to note that they cannot describe the singularly uniform water conditions round the Antarctic continent without using some convenient name, and they use Antarctic Ocean, defining it as bounded on the north by the subtropical convergence.

On the subject of submarine canyons the authors conclude that no single hypothesis yet advanced can account for the characteristic features. Possibly they should have mentioned the reminder by Shepard and Emery[1] that the very detailed contouring on the charts of the U.S. Atlantic shelf, which brought the problem into such prominence, was influenced to some extent by the erosion theory. The comprehensive study of marine sediments in the book deals with their transportation properties and environment of deposition. The authors waste no time in lamenting the discontinuance of the routine collection of bottom samples which followed the introduction of the echo-sounder, but demonstrate the importance of investigating marine sedimentation so effectively that exploring vessels will probably use apparatus capable of taking bottom cores.

The authors agree with the general assumption in meteorological literature that the transport of heat from lower to higher latitudes is effected chiefly by winds. They estimate that the proportion carried across latitude 55° in the North Atlantic Ocean is approximately one-tenth by ocean currents and the remainder by winds, and in most other regions the currents are believed to be still less effective.

In discussing the effect of ice-distribution they show that the excellent reflecting and radiating power of a snow surface favours the reduction of air temperature in the neighbourhood, so that a small lowering of air temperature in high

[1] F. P. Shepard and K. O. Emery, 1941, "Submarine topography off the California coast: canyons and tectonic interpretations." *Geol. Soc. Amer.*, Special Paper, no. 31, p. 106.

latitudes, sufficient to cause local ice formation, is likely to lead to a more rapid fall in temperature and extensive freezing. A water surface, on the other hand, reflects only a small proportion of the incoming radiation, so that a small increase in the temperature of the air flowing in over an ice-covered sea, sufficient to start the ice melting, is likely to be followed by a further rise in temperature and more extensive melting. It has been calculated that an increase of a few degrees in the average temperature of middle northern latitudes would open the Arctic Ocean.

The large section of the book dealing with the chemistry and biology of the sea is concerned mainly with the interrelations of animals and plants, their environment, and nutritional relationships. Microscopic plants are the most important consumers of inorganic material; animals may remove elements necessary for the formation of their skeletons, but take most of their materials from plants. Elements removed from the sea are returned at a later time, and probably at a different depth, but in the end the cycle is complete and the cyclic changes maintain a delicate balance which is a measure of the potential productivity of the region.

The discussion of the physical characteristics emphasizes the importance of lateral and vertical turbulence. Where observations have been closely spaced the temperature and salinity of the sea have shown variations much greater than those foreseen, and measurements with sensitive current meters have shown that current velocities vary from second to second. The authors consider prevailing winds to be the chief source of ocean currents, but also emphasize the importance of differences of climate and the configuration of the land and ocean bottom. The difficulty of making sufficient current measurements from anchored vessels makes it virtually impossible to obtain a knowledge of ocean currents without studying the distribution of physical and chemical characteristics in the light of hydrodynamical theory. The methods that have been found useful are summarized. In drawing conclusions one usually has to work without complete information of all the processes involved, and the data from one region have to be interpreted by means of knowledge gained from other regions. Conditions cannot be varied at will, and the importance of any factor has to be judged from the evidence of its influence in other regions where it acts under different conditions. It is useful to have this clearly stated, and the influence of wind, density differences, the earth's rotation, and bottom topography discussed in relation to different conditions.

The long chapter describing the principal currents and water-masses begins with the Southern Ocean, where the almost planetary simplicity of the water circulation allows sound generalizations to be based on fewer data than elsewhere. The authors believe that the circumpolar currents follow the contours of the isobaric surfaces very closely, but there is some room to doubt this conclusion, and to argue that it minimizes the meridional components. The chapter is a great contribution to the classification of oceanographical knowledge; some of the names used in describing water-masses such as East Southern Pacific Central Water seem unacceptably long, but they are explicit.

Waves and tides, as short and long waves, are treated in one chapter. Inside a storm area the surface of the sea shows little regularity, and even in the distant shallow water, where long-crested swell becomes the dominant feature, there is generally interference between swells of different length. It is not necessarily the seventh or ninth wave which is higher than the others, but there is generally some rhythm and the waves arrive in groups, some high and some low as is typical of an interference pattern. With the help of records taken at the end of the Scripps Institution pier it is shown how ocean waves can be better understood when such interference is taken into account.

The section on tides gives a clear indication of the nature of the tide-raising forces, and of the response of the oceans. Satisfactory explanations are available for some small areas, such as the English Channel and Bay of Fundy, which are used as examples, but the mathematical treatment on account of the complexity of the factors involved is shown to be almost impossibly difficult, and there seems little prospect of being able to calculate what the tides should be at all points of the coasts of the oceans. The authors give more weight to Defant's calculations of the semi-diurnal component in the Atlantic Ocean than is allowed by Proudman in a recent lecture.[1] In their consideration of tidal streams prominence is given to Fleming's demonstration that the greatest velocities can often be expected near the edge of a continental shelf, for which there is some support in the finding of coarser sediments in such areas. In the same chapter there is a section on internal waves in the sea, and it is shown that a mechanism exists for the production of relatively large horizontal velocities at great depths, with the result that submarine peaks are swept free from fine sediments.

The book is an unmistakable success and it will do much to promote and further oceanographical research. G. E. R. DEACON

REVIEWS

NORTH AMERICA

NEEDLE TO THE NORTH: the story of an expedition to Ungava and the Belcher Islands. By A. C. TWOMEY. *London: Herbert Jenkins*, 1944. 9×5½ *inches; 336 pages; illustrations and end-paper sketch-map.* 25*s*

'Needle to the North' describes how two American biologists spent some six months in 1938 collecting specimens in the Canadian Sub-Arctic. The book falls naturally into two very different parts; one is mainly concerned with a winter journey through Indian country to an inland lake in Ungava, while the other describes a spring and summer among the Eskimo of the Belcher Islands.

The winter journey was made in order to secure specimens of a fresh-water seal reported to live in certain Ungava lakes, and known to the Eskimo as "kasagea." The starting point was the Hudson's Bay Company post at Great Whale River, where the two collectors had arrived by plane in January. Accompanied by two Eskimos they travelled north up the coast by dog-sledge to the Hudson's Bay Company outpost of Richmond Gulf, where their white guide had preceded them to make arrangements with the local Indians. With toboggans replacing the sledges for the soft interior snow, and with seven or eight Indians to haul them instead of dogs, the party turned inland from Richmond Gulf. Some fifteen days of difficult travelling took them to a lake where, after several disappointing hunting days, they succeeded in obtaining specimens of the freshwater seal.

They returned to Great Whale River just in time to travel to the Belcher Islands with the manager of the Hudson's Bay Company post there. Using the post as a base, and enlisting the aid of the local Eskimo, they spent the late spring and summer in making biological collections, until they were picked up by a schooner in the middle of August.

[1] J. Proudman, 1944, "The tides of the Atlantic Ocean," *Monthly Notices, Roy. Ast. Soc.*, vol. 104, no. 5, pp. 244–56.

Mr. Twomey's account of his experiences, and especially his description of what must have been a most enjoyable summer on the Belchers, makes a readable book and covers a region about which little has been written. There are however rather too many anecdotes which have nothing to do with the story, and his frequent use of Eskimo words, with or without an explanation of their meaning, is very disturbing to the average reader and is often misleading. The reader is also left completely in the dark as to what "kasagea" turned out to be. Was it a new variety of seal or was it *Phoca vitulina*, the spotted seal, which is the usual meaning of the word among the Eastern Canadian Eskimo and in Greenland, and is commonly found in fresh water. G. W. R.

CLIMATE OF INDIANA. By S. S. VISHER. (Indiana Univ. Publns. Sc. Ser. 13.) *Bloomington, Indiana: Indiana Univ.*, 1944. 10×7 *inches; 512 pages; sketch-maps and diagrams.* $4.00

In an admirably produced volume from the Indiana University Press Professor S. S. Visher, head of the Department of Geography, has provided an exhaustive review of the climatic features of this State. Comprehensive surveys of observational data from regions of comparable extent are few in number; and this work from the Middle West is welcome as it illustrates the factors leading, among other things, to an appreciable variation in agricultural practice over 36,000 square miles of country characterized otherwise by considerable uniformity. It is pleasant to note the dedication to the often forgotten voluntary observers whose results form the foundation of the subsequent climatological study; one of these has forty-seven years to his credit, a record likely to be surpassed by few in this country or elsewhere. Meteorologists may cavil at Professor Visher's remark (p. 7) that "a knowledge of what has happened is the best basis for prediction"; but in a region where agriculture is of surpassing importance it cannot be denied that a thorough review not only of the averages but also of the range of possibilities is invaluable; and it is said in the preface that "no other state has so complete a report upon its climate."

Professor Visher however is not writing for the meteorologist, but for more general readers. The first sixty-four pages comprise a summary together with a review in non-technical language of the factors governing the climate of Indiana; the later chapters are more detailed. British readers will welcome the diversity of convenient small maps which show, to take some interesting examples at random, the comparative lengths of the shortest and longest frost-free seasons on record (p. 120), and the frequency of snow-cover (p. 207). The juxtaposition of maps is often effective; compare (p. 380) the interesting resemblance between the extent of the unglaciated area and the area subject to upwards of three days each winter with more than an inch of rain; this is obviously significant with regard to erosion. But it would greatly help readers overseas to have the map showing location of stations (p. 68) adjacent to that showing elevation above sea-level of the counties (p. 31), and none of the maps has a scale until the vegetation map is reached (p. 455).

Nevertheless the climatic information is of great variety and interest, and in discussing and interpreting the observations, tables, and maps Professor Visher maintains an easy style which will appeal to many general readers seeking factual knowledge. Some of the phrases may need qualification for the better-informed, *e.g.* (p. 49) "whenever the temperature falls as much as 18° F. the capacity of air or space for moisture is halved," and the term "high pressure cyclonic disturbances" (p. 50) is not easy to interpret. Not all meteorologists now recognize nimbus cloud (p. 291) without further ado.

Geographers are likely to find the book useful because of the opportunities

for comparison of the possibilities of the Middle West climate with those elsewhere. For example, in a region in which there is a disposition to emphasize the winter cold it is salutary to read that temperatures from 70° to 75° F. have been recorded in January over a wide area, and 90° has been touched in March. Such upward departures of the absolute from the normal monthly extremes are of similar magnitude to those experienced inland in England; but in the opposite direction the intermittent occurrence of a deep snow-cover in the southern part of the state (average frequency of snow-cover adjacent to the Ohio is less than fifteen days annually) can produce very severe departures in the direction of extreme cold. The departures from normal of the mean temperatures of the coldest and warmest Januaries are each about one-and-a-half times that recorded in Britain; while those for July are much the same in both countries.

The frequency of days with heavy rainfall and also the incidence of drought are analysed with care. British readers will find that one of the few elements in which we can approach Indiana is, somewhat unexpectedly, with regard to the maximum rainfall recorded for a single day (p. 230)—the figures, ranging from about 4 to over 8 inches, are of much the same magnitude in both countries. The frequency of days with measurable rain is lower; the range of variation between dry and wet years much the same (from 62 to 144 per cent. of the normal 40 inches at Indianapolis, 1861–1940). Evaporation data are dealt with briefly; an average of 30–35 inches appears to prevail. The relationship of snow-cover, frost, and the incidence of intense rainfalls to soil erosion and to agricultural practice is very well brought out; and the chapter on Climate and Physiography will be regarded by many geographers as among the best in the book. Professor Visher has built up from his own papers convincing evidence of the importance of further study of regional contrasts in rainfall intensity.

Other climatic elements such as thunderstorms (nearly three times as frequent as in our East Midlands), wind speed with some notes on upper winds, and sunshine and cloud are discussed in detail. British readers will no doubt vary in their opinion whether a city in the temperate zone receiving 115 hours of sunshine in December is really inadequately provided (p. 286), followed by the statement that health suffers unless fish-liver oil or ultra-violet lamps are used. Not the least interesting of the adaptations undergone by the majority of European immigrants is that represented by the contrast between the annual sunshine totals: Cambridge (1525 hours), Berlin (1667), or Rome (2410), with Indianapolis (2602). And, following Huntington, Professor Visher considers that Indiana often "has temperatures too high to be favourable for man's intellectual activity" (p. 93).

Climate and its relationships with crop yield and public health and notes on the prevailing weather on public holidays provide useful chapters. The importance of micro-climatic differences is not overlooked.

The latter part of the book comprises a series of tabulated data for five representative stations. For example, values of the mean temperature are given for every day of the year. These are evidently "smoothed"; it would have been interesting to see whether there is any persistent tendency for irregularities in the annual temperature to occur such as those noted at Washington, Stockholm, or Greenwich. Occasional errors may be found; for example, the highest temperature on record at Bloomington is given as 109° on p. 462, and 110° on pp. 469–71; while the lowest on record for July is given as 36° (p. 471) and 46° elsewhere.

In all, Professor Visher is to be congratulated on the result of his lengthy labours; and, in addition to the value of the book as a source of detailed information for those interested in the American Middle West, geographers will appre-

ciate his climatic approach to regional sub-division. This readable summary of what to many may be a dry subject may also serve to remind some that comparisons of the merits and demerits of maritime and continental climates are for long likely to provoke argument. G. M.

CENTRAL AND SOUTH AMERICA

JUNGLE IN THE CLOUDS. By VICTOR W. VON HAGEN. *London: Robert Hale*, 1945. 8½×5½ *inches; 223 pages; illustrations and end-paper sketch-map.* 15*s*

Mr. von Hagen writes of his visit to Honduras in 1937. He was accompanied by his wife and their primary object was to secure living examples of the rare quetzal bird for the New York and London Zoological Gardens. In the first half of the book the difficulties of the search and its final success are related. This includes an interesting account of the nesting habits of the birds and some excellent photographs of the fledglings, which are strangely unlike the mature birds.

Mrs. von Hagen is a botanist and the author an ethnologist as well as a zoologist. The discovery of some families of Jicaque aborigenes, who make cloth from the bark of the wild fig tree and shoot their game with clay pellets from a blow gun, led to an account of their ethnology, which has been published by an American museum. Here is only a shortened version written to suit the popular taste in America. The von Hagens managed to make friends with the tribe and obtained, with ethnological information, some excellent casts of their features. The book ends with some chapters describing the now well-known ruins at Copan. Here the author's testimony as a zoologist that there are no representations of elephants is of value. Professor Elliott Smith's elephants become turkeys, quetzals, and blue macaws.

The book is marred by the lack of an index, perhaps due to war-time restrictions, and by a few spelling mistakes. For example, "chichirones", p. 29, should be "chicharrones," "hæphæ," p. 75, should be "hyphae," and "perico legiro," p. 131, "perrico ligero." Sir Richard Owen on p. 36 should be Mr. Robert Owen. A. H. G. A.

AUSTRALASIA AND PACIFIC

FRAGMENTA PAPUANA: observations of a naturalist in Netherlands New Guinea. (Sargentia, vol. 5.) By H. J. LAM. Trans. by LILY M. PERRY. *Jamaica Plain, Mass.: Arnold Arboretum of Harvard Univ.*, 1945. 10×7 *inches; 196 pages; illustrations and sketch-map.*

This book is a translation of a series of articles originally published in Dutch periodicals, which now appears because, as Professor Merrill states in his preface, the necessity for emergency foods has created a great demand for information regarding the poorly known flora of the south-west Pacific region.

Professor Lam was the botanist who accompanied Captain van Overeem's expedition up the Mamberano river in 1920–22. The Mamberano is the largest river on the north coast of Netherlands New Guinea; it rises in the high mountains in the centre of the island and, after a course of 900 kilometres, enters the sea at Cape d'Urville. The river was followed as far as Prauwen–Bivak, after which the expedition proceeded overland with a large following of Dyak porters and convicts and eventually reached Doormantop, 3580 metres.

The author's interests were mainly botanical and he describes the flora from sea-level to the mountain top in great detail. This kind of detailed description

gives a very good idea of the various types of country through which the explorers passed. It is illustrated by schematic representations of cross-sections of the forest. After leaving the tropical rain forest, the expedition reached a zone of forests where coniferae predominated; at about 3000 metres these were replaced by *Casuarina*. The tree-line was reached at 3500 metres, and above this level certain European genera appear, *Rhododendron*, *Gentiana*, *Rubus*, and *Potentilla*.

Professor Lam refers to a number of other botanical topics and discusses the curious pollenation of *Boerlagiodendron* by birds. On another page he refers to the phenomenon designated "stenophylly" by Beccasi, which is the development of narrow-leaved plants in ravines in tropical forests. Luminous patches of ground in the forest are mentioned and thought to be due to the mycelia of fungi. He comments on the extraordinary wealth of ferns, both species and individuals, crowded together in the forest.

There follows a very thorough discussion of the relationships of the flora in which the importance of New Guinea as a centre of development and distribution is stressed. The author gives a list of natural foods procurable in the forest, which sounds quite attractive. He considers that it is possible to live on the land at low levels, but not in the high mountains, where food is much scarcer.

The latter part of the work is mainly anthropological and describes the lives of the Timorini, who live in the sunny valleys on the southern slopes of Doormantop. Stone axes were the only tools which these people possessed, but with such implements a suspension-bridge shown in a figure had been constructed. Lam mentions their food plants and thinks that possibly the sweet potato and tobacco may have spread from America to the archipelago before the arrival of Europeans in 1545. A. H. G. A.

BRITAIN AND THE SOUTH SEAS. By Sir HARRY LUKE. *London: Longmans, Green*, 1945. 7×4½ *inches; 72 pages; illustrations and sketch-map.* 1s

Within the narrow compass of seventy pages Sir Harry Luke has provided an introduction to the study of British affairs in Oceania so clear and quiet that few will appreciate the outstanding success of its presentation. Nothing could be easier to read. But on tranquil consideration the appearance of simplicity vanishes. The author's theme, implied but nowhere formulated, is the changing course of British interest, influence, protection, and rule in islands of the Pacific. This enables him to say a good deal about Tahiti but forbids him from saying much about New Caledonia; obliges him to say something about Norfolk Island and Lord Howe Island (N.S.W.) but saves him from having to mention the Kermadec Islands. To give a straightforward account of the general geography and history of the South Pacific is not his purpose. The course of native and European exploration and occupation in Micronesia, Melanesia, and Polynesia are therefore sketched lightly, with no more emphasis than is needed to explain the nature of British responsibility in the regions now. The main interest is in administration. The peculiar government of Nauru leads incidentally to the frequent mention of guano, but the great export wealth of other islands, in copra, sugar, and bananas, is given only passing mention.

The present state of administration of native affairs is highly creditable to the Empire, and should be made known. "It is not always realized as widely as it should be," writes Sir Harry Luke, "how many parts of our Colonial Empire have come under the British Crown at the express desire of their inhabitants, but against the wishes of the British Governments of the day" (p. 39). Elsewhere he says that "One of the results of British rule in the Pacific has been to arrest the depopulation from which this part of the world had suffered to so

terrible an extent. . . . In all the British Groups the native population is now definitely on the increase" (p. 66). Of leprosy in particular he says that "Between 1918 and 1943, 696 patients were discharged from Makongai [Fiji] as cured" (p. 68). Recalling that the 'Essays on the depopulation of Melanesia,' edited by the late W. H. R. Rivers, were published only in 1922, these are astonishing achievements. Our "former Colonial policy, . . . of insisting that Colonies, however scanty their revenues, must pay their way" (p. 65), has been quietly adjusted to changes in public opinion brought about, mainly, by those who have worked on behalf of the natives, such as "the missionary and the Government official together with the doctor, who belongs to both categories, and, more indirectly, the anthropologist" (p. 65).

The faults of the book are due mainly to the problems of compression, and are faults of over-simplification. They are well illustrated by the statistical tables on pages 70 and 71, which give the population, and name the indigenous race, in each territory. These, for Fiji, are given as 227,000 (1941), and Melanesian. This is misleading unless one refers to the text, where it appears that only 105,000 of the total are Fijian while no less than 98,000 are Hindu. ("The Statesman's Year-book' (1945) gives markedly higher figures for 1943.) This is not presented as involving a problem, but it represents a state of affairs well understood in the Sandwich Islands, where, out of a total population of 423,330 in 1940, only 14,375 were Hawaiians of pure blood, while 157,905 were Japanese. Hawaii and Viti Levu are the largest and most highly developed islands in the central Pacific, and in Fiji Hindustani is as useful a language, on the plantations and in the mills, as Fijian. Sir Harry Luke mentions the diversity of languages in many parts of Melanesia several times, but says nothing of how the difficulty has been overcome. The south-west Pacific has had its trade jargon ("beach la mar") since whaling days. The *lakatoi* men, the sailor-traders of the south coast of Papua, have developed a native *lingua franca* along their main routes; and the Government, by training the Papuan native police in Motuan, the language of Port Moresby, has spread the official use of a native language widely through the territory. The less dignified beach la mar, wrongly called pidgin, is used in the neighbouring mandated Territory of New Guinea. Australians may regard Sir Harry Luke's accounts of the annexation of British New Guinea (now Papua), and of the growth of the Anglo-French Condominium of the New Hebrides (pp. 53–56) not as incorrect but as unsatisfactory in appreciation of historical circumstances, part of the intimate, unofficial record of the Colonial Conference of 1887 being well known in Australia through Walter Murdoch's book 'Alfred Deakin: a sketch' (London, 1923). And a generation anxious to redeem the mistakes of the past may not be satisfied with a simple condemnation of "blackbirding," which was a symptom rather than the disease. The classification of the islands as high or volcanic, and low or coralline is faulty. The high islands of Melanesia are by no means primarily volcanic. Many of them, including those of Fiji, are continental in their geological relationships; and the over-simplified Darwinian explanation of atolls is unnecessary. A purely geographical classification into high and low islands, with some reference to the very different windward and leeward aspects of many of the former, would have been enough for the purposes of the book. The name Fiji is explained as a European corruption of the native Viti. According to Hazlewood (1872) and Laborde (1918), Fiji is the form of the name in the windward dialects (towards Tonga) while Viti is that of the leeward dialects. The P.C.G.N. 'First list of names in Fiji' (1925), which was submitted to the Government of Fiji before publication, goes even farther, and states that the form Fiji is Tongan.

It is unfair however to dwell too long on the faults of this admirable little book. In its few pages it gives a clear conception of historic change in the islands of Oceania, shows them losing their precarious independence, ruthlessly exploited from both sides of the Pacific, seeking the protection of remote, civilized governments, and now gradually coming under the administration of English-speaking states bordering the Pacific, with purely native affairs being left more and more to native management. The book is too small to bring one into real touch with these island peoples, but it is illustrated with a discriminating choice of very representative photographs. Some of the most interesting passages are those relating to the Gilbert and Ellice Islands. They make one wish that Sir Harry Luke could be persuaded to produce an independent account of each group of islands which came under his administration. M. A.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

WEATHER AROUND THE WORLD. By I. R. TANNEHILL. *Princeton: University Press, 1944 (London: Humphrey Milford).* 8×5 *inches;* xii+200 *pages; illustrations and diagrams.* 16*s* 6*d*

Professor Tannehill is well known in this country as an authority on tropical revolving storms, and in this pleasantly produced book he has set out to provide the general reader with a descriptive summary of the outstanding climatic features of the world; indeed he suggests that it should be regarded as "a weather supplement to the traveller's guide book." His interests however have led him to devote rather more attention than is usual to the characteristic climatic features of the oceans, especially on the frequented shipping routes; and appropriate reminders are given of the impressive pioneer work by Lieutenant Maury of the United States Navy just a century ago. Accordingly the reader will find scattered through the chapters much interesting general information, summarizing in brief compass the material for which detail is to be sought in the larger standard works. To these chapters are added a useful selection of cloud photographs, both classical and recent. G. A. Clarke's excellent "Rainbow" and "Halo in cirrostratus" come under the first heading; an R.A.F. photograph of clouds over Egypt is an example of the latter.

The quest of brevity inevitably leads to statements provocative of interest such as the mention of the hurricane of August 1873, which devastated parts of Labrador, and the quotation of the lowest recorded temperature in London as 9°. Actually this refers to the Kew north-wall screen since 1871, and at the same place 1° was recorded in 1867. For this however the blame attaches more to our official tables than to the author; and the same might be said of the data from many large cities. Scotsmen in particular will be reminded of a perennial source of transatlantic argument by the statements (pp. 51–52) that "the ideal temperature for an American . . . is about 68°" and "for physical exercise out of doors . . . some investigators have concluded it should be about 60°." On p. 115 some will question whether the usual course towards Mount Everest is from Leh via the Manasarowar Lakes.

In the tables the mean daily maximum and minimum are given for each month for one hundred and ten (mainly coastal) stations scattered over the earth, together with average humidity as a percentage of saturation; whether these last are always strictly comparable is not clear. Recorded extremes for each month, average number of days with rain (also snow), and average cloudiness are also tabulated. No station is given for South Island, N.Z. For seventy-five other stations, mainly inland, monthly means of temperature and averages of rainfall are given. As a quick source of information these tables are un-

doubtedly useful and Professor Tannehill will be applauded by many for his reminder to the reader that tables like these should not be avoided as dull. The mean daily maximum of 73° for July at Montreal, although in agreement with the context, seems rather low by comparison with the averages quoted in older works.

The summary of climatic features on the chief ocean crossings is welcome. For the general reader there is so much of interest in the book as a whole that further references for reading will frequently be sought; a short bibliography would help those who are situated far from libraries. Apart from this Professor Tannehill's book will usefully fulfil the purpose for which it has been designed.

G. M.

GENERAL

MINERALS IN INDUSTRY. By W. R. JONES. (Pelican Books.) *Harmondsworth: Penguin Books*, 1943. 7×4½ *inches; 150 pages; sketch-maps. 9d*

Several attempts have been made recently to encourage general knowledge of the mineral resources of Great Britain. Such a complex subject is extremely difficult to deal with for the general reader, but Professor Jones's account, which covers the vast subject of world distribution and uses of minerals in industry, is masterly. This book will do much to dispel the erroneous idea that Britain ranks as a first-rate producer of the minerals upon which her industries are dependent. Apart from iron ores we are unable to supply our needs of such important metals as aluminium, tin, copper, and manganese from home sources. We are reminded by Professor Jones that with "the single exception of the Soviet Union, all major steel-producing countries are markedly deficient in domestic supplies of chromite and have to rely on imports for their requirements." However it is not his intention to describe the strategic importance of minerals, but their varied uses in industry. For this purpose he has drawn upon his first-hand experience of developing mineral resources in many parts of the world, and great knowledge of the literature.

By discussing each mineral in alphabetical order Professor Jones has forsaken the traditional practice of describing them in groups according to their chemical or mineralogical properties, or in relation to the industries in which they are employed. This bold departure naturally leads to some difficulties, not the least being the repetition caused by the use of several minerals in the same industrial process. However difficulties have been skilfully avoided and the new presentation is most refreshing.

The geographer and student of economic mineralogy will find clearly condensed a vast amount of up-to-date information, not usually found in textbooks dealing with minerals. The book provides a stimulating background to a more serious study of the subject. Professor Jones tells how minerals like vermiculite, which were unknown twenty years ago outside geological circles, are finding extensive use in industry for light sound-proof building materials, and as a substitute for graphite in oilless lubricants for bronze bearings. He also tells of the employment of large quantities of diamond in industry, particularly the black variety, carbonado, and the discoloured type, bort, which are chiefly obtained from the Brazil and African fields respectively. And it is interesting to learn that aluminium competes seriously with copper in the construction of long-distance transmission lines, as a result of the discovery of cheap methods of extracting the metal from bauxite and its lightness, which permits a considerable reduction in the number of supporting towers.

The graphical illustrations of the average world production of these various minerals are most informative. In addition there are five world maps showing

the distribution of the principal sources of these minerals. Even with the serious limitation of length imposed upon the author he has succeeded in his object of writing the story of the uses of minerals in industry. Moreover his amusing sidelights on some of the world's largest industries will undoubtedly capture the attention of the general reader, and the presentation will receive high praise from his fellow geologists. If Professor Jones would expand this work into a larger volume it would assuredly find a place on the bookshelves of all geologists, geographers, metallurgists, and the many others interested in the economic aspects of mineralogy. W. D. E.

ADDITIONS TO THE LIBRARY

This list contains books and periodicals for the most part received in the Library during 1945. Inclusion in this list does not imply that a work has not been, or will not be, reviewed in the *Geographical Journal*

EUROPE

SMALL FARMERS AND PEASANTS OF EUROPE BEFORE AND AFTER THE WAR
By Sir E. John Russell. (*Geogr. Rev.* 35 (1945) 1–11)

LES PORTS DE L'ESTUAIRE DE L'ESCAUT, DE LA MEUSE ET DU RHIN
By A. Delmer (*Bul. Soc. Belge Etudes G.* 14 (1944) 63–97)

ENGLISH CITY: the growth and the future of Bristol
Published by Messrs. J. S. Fry. 11×8½. 188 pp. Illustrations. *London: Univ. of London Press*, 1945. 6*s*

THE RAINFALL OF THE WREXHAM DISTRICT
By S. E. Ashmore. (*Quart. J. R. Met. Soc.* 70 (1944) 241–74)

STUDIES ON THE SOILS DEVELOPED ON BASIC IGNEOUS ROCKS IN CENTRAL ABERDEENSHIRE
By R. Glentworth. (*Trans. R. Soc. Edinburgh* 61 (1944) 149–70)

THE ORIGIN OF THE WEST CUMBERLAND HAEMATITES
By F. M. Trotter (*Geol. Mag.* 82 (1945) 67–80)

THE LAND OF BRITAIN. Reports Pt. 15. Caithness
By S. W. E. Vince. 11×8½. 59–122 pp. Maps. *London: Land Utilisation Survey*, 1945. 4*s*
Several other parts have recently been received, including the Lothians, North Riding of Yorkshire, and Northumberland.

A PLAN FOR PLYMOUTH: the report prepared for the City Council
By J. P. Watson and others. 2nd ed. 12×9½. xvi+147 pp. Illustrations. *Plymouth: Underhill*, 1943

PROSPERO'S CELL: a guide to the landscape and manners of . . . Corcyra
By L. Durrell. 9×5½. 142 pp. Illustrations. *London: Faber*, 1945. 10*s* 6*d*

TWENTY-FIVE YEARS OF THE STUDY OF THE QUATERNARY IN THE U.S.S.R.
By V. Gromov. (*Amer. J. Science* 243 (1945) 492–516)

ESPAÑA, EL PAIS Y LOS HABITANTES
By L. M. Echeverria. 9×6. 488 pp. Illustrations and maps. *Mexico City*, 1940

GEOCHRONOLOGIA SUECICA PRINCIPALES
By Gerard de Geer. (*K. Svenska Vetenskapsakad. Handl.* 3 *Ser.* 18, No. 6 (1940) 1–368, and vol. of plates)

LA SUISSE ROMANDE
By C. F. Ramuz. 9×6½. 200 pp. Illustrations. *Grenoble: Arthaud*, 1936

ASIA

BALI
By P. H. Hiss. 12½×9. xv+112 pp. Illustrations. *London: Hale*, 1941. 42*s*

CHINA, MY CHINA
By H. B. Rattenbury. 8½×5½. 272 pp. *London: Muller*, 1944

AN ANALYSIS OF THE VARIATIONS IN RAINFALL AT AKOLA, BERAR, INDIA
By T. C. Carruthers. (*Geogr.* 30 (1945) 69–79)

THE PROBLEM OF POPULATION AND FOOD PLANNING IN SIND
By G. S. Raisinghani and M. B. Pithawala. (*Calcutta G. Rev.* 7 (1945) 35–65)

THE FLOOD PROBLEM IN IRAK
By E. V. Richards. (*Journ. Inst. Civil Engin.* 1945, 145–68)

GOKKANOSHO: a remote corner of Japan
By J. F. Embree. (*Sc. Monthly*, 1944, 343–55)

SIAM: the crossroads
By Sir Josiah Crosby. $8\frac{1}{2} \times 5\frac{1}{2}$. viii +174 pp. Illustrations. 12*s* 6*d*

An account of the political and economic development of Siam during the last forty years by a diplomat with first-hand knowledge of the period. Special attention is given to international relations. The author believes that "Britain is cast for the role of Siam's best friend and supporter in the time that is coming."

EARLY MAN AND PLEISTOCENE STRATIGRAPHY IN SOUTHERN AND EASTERN ASIA
By H. L. Movius. (*Papers Peabody Mus. Amer. Archaeol.* 19 (1944) No. 3, 125 pp.; s.m. illustr.)

AFRICA

GEOGRAPHICAL FACTORS IN ROMAN ALGERIA
By A. N. Sherwin-White. (*Journ. Roman Studies* 34 (1944) 1–10)

RASGOS FISIOGRAFICOS Y GEOLOGICOS DEL TERRITORIO DEL IFNI
By F. Hernandez-Pacheco. (*Bol. R. Soc. G. Madrid* 81 (1945) 47–62)

THE CONTRIBUTION OF COLONIAL GEOLOGICAL SURVEY TO THE DEVELOPMENT OF THE MINERAL AND OTHER RESOURCES OF EAST AND WEST AFRICA
By Sir Edmund Teale. (*Journ. R. Soc. Arts* 92 (1945) 245–56)

GEOGRAPHICAL AND TOPOGRAPHICAL DESCRIPTION OF THE CAPE OF GOOD HOPE, Part 3
By F. Mentzel and others. (Van Riebeeck Soc. vol. 25.) $8\frac{1}{2} \times 5\frac{1}{2}$. xxv+ 354 pp. *Cape Town*, 1944

TANGANYIKA TERRITORY: a study of economic policy under mandate
By C. Leubuscher. (R. Inst. Internat. Affairs.) $9 \times 5\frac{1}{2}$. x+218 pp. *London: Oxford U.P.*, 1944. 18*s*

The author concludes with suggestions for improving the machinery of the mandates system, but does not favour direct international administration.

AMERICA

ESKIMOLAND SPEAKS
By W. B. Van Valin. $9 \times 5\frac{1}{2}$. 202 pp. Illustrations. *London: Museum Press*, 1945. 12*s* 6*d*

The author, a former official of the U.S. Bureau of Education, describes the life of the Alaskan Eskimo from thirty years' experience of the country.

FORESTS AND GARDENS ALONG THE ALASKA HIGHWAY
By H. M. Raup. (*Geogr. Rev.* 35 (1945) 22–48)

THE ALEUTIAN ISLANDS: their people and natural history
By H. B. Collins and others. (*Smithsonian Inst.: War Background Studies*, No. 21 (1945) 129 pp.; illustrations)

THE DRAINAGE PATTERN IN ALBERTA
By P. S. Warren. (*Trans. R. Canadian Inst.* 25 (1944) 3–14)

LAND USE POSSIBILITIES IN MACKENZIE DISTRICT, N.W.T.
By J. J. L. Robinson. (*Canadian Geogr. J.* 31 (1945) 30–47)

ILL FARES THE LAND: migrants and migratory labour in the United States
By C. McWilliams. 8×5. 245 pp. Sketch-maps. *London: Faber*, 1945. 12*s* 6*d*

The author shows that the social problem of the migratory labourers has arisen from revolutionary changes in the structure of American agriculture, *e.g.* mechanization, large-scale business management, and unsound land tenure. He considers that the fundamental requirement is public control of industry, agriculture, and finance.

PHYSIOGRAPHIC DIVISIONS OF THE COLUMBIA INTERMONTANE PROVINCE
By O. W. Freeman and others. (*Ann. Assocn. Amer. Geogrs.* 35 (1945) 53–75)

AUSTRALIA: THE PACIFIC

A SOIL MAP OF AUSTRALIA
By J. A. Prescott. (*Austr. Council Sc. Research* 177 (1944) 15 pp.; map)

LAND UTILISATION SURVEYS IN THE KURRAJONG-WINDSOR DISTRICT, N.S.W.
By W. H. Maze. (*Australian Geogr.* 4 (1943) 155–74; sketch-maps and illustrations)

GEOLOGY OF LAU, FIJI
By H. S. Ladd and J. E. Hoffmeister. (*Bul. B.P. Bishop Mus.* 181 (1945) 400 pp.; maps)

PAPUA: ITS PEOPLE AND ITS PROMISE
By L. Letts. $8\frac{1}{2} \times 5\frac{1}{2}$. 108 pp. *Melbourne: Cheshire*, 1944

GUADALCANAL ROUND TRIP
By A. S. Campbell. 7½×5. 112 pp. *Princeton, N.J.: Univ. Press*, 1945

MOUNTAIN GROWTH; a study of the southwestern Pacific region
By W. H. Hobbs. (*Proc. Amer. Philos. Soc.* 88 (1944) 221–68)

PHYSICAL AND MATHEMATICAL GEOGRAPHY

STAR COMPASS: longitude finder, star clock, and planisphere (Model for 50°–55° N.)
By F. Chichester. 6×5½. 44 pp. *London: Allen and Unwin*, 1945. 5*s* 6*d*

RECENT DEVELOPMENTS IN AIR PHOTOGRAPHY
By H. H. Thomas. (*Nature* 156 (1945) 409–11)

GRAPHICS OF WORLD AVIATION
By A. J. Dilloway. (*Journ. R. Aeronaut. Soc.* 49 (1945) 112–40)

SOME FACTORS IN MICRO-CLIMATOLOGY
By D. Brunt. (*Quart. J. R. Met. Soc.* 71 (1945) 1–10)

METEORITES AND SOME OF THE PROBLEMS WHICH THEY PRESENT
By Lord Rayleigh. (*Endeavour* 3 (1944) 127–35)

WATER CIRCULATION AND SURFACE BOUNDARIES IN THE OCEANS
By G. E. R. Deacon. (*Quart. J. R. Met. Soc.* 71 (1945) 11–25)

IRON AND MANGANESE ON THE OCEAN FLOOR; a contribution to submarine geology
By H. Pettersson. (*Medd. Oceanogr. Inst. Göteborg* 7 (1945) 36 pp.)

HUMAN AND HISTORICAL GEOGRAPHY

AGRICULTURE: to-day and to-morrow
Ed. by Sir E. John Russell. 7½×5. 200 pp. *London: Joseph*, 1945. 8*s* 6*d*

INTERNATIONAL SEA TRANSPORT. (R. Inst. Internat. Affairs)
By Sir O. Mance. 8½×5½. xii+198 pp. *London: Oxford Univ. Press*, 1945. 12*s* 6*d*

THE PROBLEM OF SECURITY
By Sir G. Martel. 8×5½. 172 pp. *London: Joseph*, 1945. 10*s* 6*d*

WORLD POPULATION PROBLEMS
By R. R. Kuczynski. (*Internat. Affairs* 20 (1944) 449–57)

THE ENGLISH GEOGRAPHERS AND THE ANGLO-AMERICAN FRONTIER IN THE 17TH CENTURY
By F. Mood. (*Univ. California Publn. Geogr.* 6 (1944) 363–95)

RUSSIAN VOYAGES ROUND THE WORLD
By N. Nozikov: transl. by E. and M. Lesser. 8½×5½. xx+166 pp. Sketch-maps. *London: Hutchinson*, 1945. 12*s* 6*d*

BRITISH MAPS AND MAP-MAKERS. (Britain in pictures.) 2nd imp.
By E. Lynam. 9×6½. 48 pp. Illustrations. *London: Collins*, 1944. 4*s* 6*d*

THE MONTHLY RECORD

JOURNEYS IN SOUTH-EAST CHINA

We have received, through the British Council, extracts from Dr. Joseph Needham's report on journeys in the south-east of China from April to June 1944. In a 30-cwt. ex-ambulance Dr. Needham drove from Kūkong in Kwangtung to Kanhsien in Kiangsi, thence to Changting and Nanping in Fukien, returning to Kanhsien by way of Shaowu and Ningtu. In Kwangsi he describes a journey from Patpo to Liuchow. The following account of the roads and railways is taken from Dr. Needham's report:

"Leaving Kūkong for Changting, the road is very bad until the Kwangtung–Kiangsi border is reached, when it greatly improves. The first 30 kilometres passes through much volcanic plug or mesa type of country. The border is reached at the Tayuling pass. Between this point and Kanhsien there is a stretch of some 15 kilometres where the road was much cut about and obstructed by the building of a large American airfield.

"Leaving Kanhsien for the east we crossed the Kung river on a producer-gas twin-screw ferry; this was quite efficient. From here to Yūtu the road is excellent, through sandy country. At Yūtu we were delayed two days by engine trouble and flood-water covering the Juikin road. Juikin was the former capital of the Communist area. After Juikin the road rises through country resembling the French Jura mountains, or northern California. The Kiangsi–Fukien boundary is nearly at the top of the Meililing pass, and the road at once becomes more narrow, winding, and steeply graded. In fact throughout Fukien the roads, though moderately well looked after, are poor.

"Between Changting and Yungan the road, which is little used, goes through wild mountainous country. We went over the Niudoling (the Bullring pass), and then the Sungmaoling pass, where the lovely wild *Gardenia angustifolia* was found in profusion. After Pengkow, the junction of the road to Amoy, the Chinchiling (Gold chicken pass) must be crossed: the hillsides were covered with wild pale pink *Rhododendron mariaci*, and at the top, among the clouds, with bright red *R. indica*, var. *ignescens*. The gradients on this road are bad.

"The road from Yungan, down the Min river valley to Sanyüan and Shahsien, through thick forest country, is relatively good for Fukien. There is a ferry before Nanping. This lovely but disease-ridden (malaria, plague, etc.) country was taking heavy toll of the Chinese army. Between Yungan and Sanyüan we passed many small parties of sick soldiers being driven on to some concentration point. The road between Nanping and Kienyang was very bad even for Fukien, the surface being deeply pitted and the bridges unsafe. Between Kienyang and Shaowu the road improves. Shaowu stands in lonely country across a river from the isolated bus station.

"Beyond Shaowu the border is reached at Kwangtseh after a ferry at Hohsun. The roads immediately improve; we could drive over 40 miles per hour, which is not possible elsewhere, even in south Kiangsi. Crossing a long and ancient stone bridge into Nancheng we were shocked by the destruction caused by the Japanese when the city had been in their hands in the previous year. The road surface continues good through Nanfeng to Mingtu, Yinkang, and Kanhsien.

"In Kwangsi we made careful observations on the roads south of Kweilin. Among the karst limestone pinnacles, and through the sandy hills and foothills of the mountains separating the province from Kwangtung in the east, the road surface was very variable, in general rough, but not spoilt by too much traffic,

and with a tendency to be cut up by torrent run-offs. From Laipo to Patpo the road passes through a country of thin population and considerable animal husbandry. On this stretch there are two ferries. Between Pinglo and Chungshan the road is much better than it looks. There is a curious bridge between Tongan and Chungshan, consisting of a floating barge permanently moored. While crossing the Pinglo ferry we saw boats coming upstream, with a capstan manned on the first one winding in a rope from a fixed point—the usual process reversed, the pullers on the ship and not on shore. Westward of Laipo the road was excellent from there to Liukiang, because practically empty of traffic, but very bad from there to Luchai over a dreary moor, and better but grass-grown alongside the railway till Loyung, and then better still. Between Laipo and Liuchow there were four ferries.

"Throughout we used power alcohol. In Kwangtung we could have run, if desired, on cracked camphor wood oil gasoline. In Fukien we could have used the cracked pinewood oil gasoline. These were about the same price as power alcohol.

"*Railways:* The journey from Kweichow to Kwangtung province is made by three railways: the Chien–Kuei railway from Tuhshan to Liuchow, the Hsiang-Kuei railway from Liuchow to Hengyang, and the O-Han railway from Hengyang to Kükong. The engineering on the first of these was remarkable, the descent from the high plateau of Kweichow to the pinnacled plains of Kwangsi being accomplished by many twists, turns, and tunnels, and a series of dead ends at which the train reverses, backing down or up as the case may be, to another dead end on a lower level. The best construction was that of the Hsiang-Kuei line, especially the bridges, as was found, somewhat unexpectedly, by those who had to blow them up at the latter part of the period covered by my tour.

"Though qualified by some special study of railway technology, I had no criticism to make of the operation of these railways by the Chinese. As is so often the case in China, the commotion and confusion in station-master's offices, signal boxes, and the like, was more apparent than real. Only towards the end, when it was foreseen that all the lines, at least as far back as Kweilin, would be lost to the Japanese, was there any real traffic dislocation.

"The great difficulty of all these railways was coal. The O-Han had mines adjoining a place at the top of the Kwangtung–Hunan divide between Pingshek and Chenhsien, but both Hsiang-Kuei and Chien-Kuei were largely dependent on the coal from Patpo in east Kwangsi which reached them at Liuchow, having had to descend one river by boat to Wuchow in Kwangtung and then ascend another to Liuchow or Kweilin. This bottleneck was a great handicap to railway operation.

"At Tuhshan, which reminded me of Grant's pass on the California–Oregon border, most of the locomotives in use were Czech (Skoda). One was French-built, but all were of American pattern. On the other railways there was a bewildering mass of rolling stock and locomotives, apparently from every country in Europe, and the U.S.A. as well. A considerable number of freight cars built in Shanghai were noted.

"The value of these standard-gauge railways for the development of the provinces was impressive. It is to be hoped that nothing will be allowed to impede the rapid repair of these lines, the early extension of the Chien-Kuei to Kweiyang, and the linking of Kunming, Chungking, and Chengtu by rail."

The place-names, where possible, have been altered to conform with the spelling of the Chinese List of Post Offices.

VISIT OF GENERAL FEDEROV

At the meeting of the Society on November 12, when Professor Ahlmann, the distinguished Swedish geographer, read his paper on "A summary of glaciological researches, 1918–40," we were glad to welcome Lieut.-General Federov, of the Russian Army. General Federov is probably better known to many Fellows as Dr. Federov, one of the members of the Soviet Arctic Expedition of 1937–38. On 21 May 1937, General Federov and his three companions took off from the new air base at Prince Rudolf Island and landed on an ice-field some miles from the North Pole. Additional supplies were flown in by three other aircraft. In all the expedition drifted some 1500 miles from the North Pole to the latitude of Scoresby Sound, Greenland. This drift lasted nine months, and the small party was finally rescued as the floe was breaking up in the neighbourhood of 70° N.

General Federov took part in the Discussion following Professor Ahlmann's paper and presented two volumes of the scientific results of the drift expedition to the Society. Both volumes, entitled 'Publications, Drift Station, North Pole,' are in Russian, and neither has hitherto been received in this country. The first volume, published in 1940, contains the following sections: Expedition to the Pole, Drift Station, Flights, Wireless station "Upol," and Astronomical determinations. The second volume, dated 1941–45, mainly contains meteorological results, notes on meteorological equipment, and a section on the circulation of the atmosphere in the central polar basin. These results have been awaited with great interest and we shall look forward to publishing a longer note about them in a coming number of the *Journal*.

EXERCISE MUSK-OX

In the *Times* for November 10 there was a preliminary account of a joint Canadian Army and Air Force exercise, which is to take place this winter in the Canadian Arctic. This exercise, known as Exercise Musk-Ox, is planned to test vehicles and equipment under Arctic conditions and to augment the scientific information obtained in 1944 in the coastal mountain regions of Canada. We have received more detailed information in a letter from Col. J. T. Wilson, Director of Operational Research in Ottawa: he writes "Training is now starting and the force expects to leave Churchill on 14 Feb., arriving Cambridge Bay 10 Mar. and Edmonton 5 May. A ground party of less than 50 will travel by modified Canadian armoured snowmobile which was proved a sound vehicle last winter. They will be supplied by twin-engined aircraft operating from air bases, most of which were established permanently during the war. Of the moving force more than a third . . . will be making observations on such subjects as meteorology, magnetism, navigation, vehicle performance, physics of snow, air supply, mapping, game, ice thicknesses and other subjects. The exercise is entirely non-tactical but designed to try out living and moving in the Canadian Arctic."

Four Fellows of our Society are taking prominent parts in this operation: Col. Wilson, on the planning side in Ottawa; Lieut.-Col. Patrick Baird, who will be in command of the moving force; Lieut.-Col. Andrew Croft, acting as War Office observer; and Major Graham Rowley, who will set up the advanced meteorological base at Baker Lake, district of Keewatin, N.W.T.

GERMAN GEOGRAPHERS

In a letter from Professor Troll, of Bonn, we have received news of some of the German geographers. Professor Troll, who has been offered the Chair of Geography at Berlin, is hoping to revive the German Geographical Society, the Gesellschaft fur Erdkunde zu Berlin, of which, in 1939, he was an Acting Presi-

dent. Of the other Acting Presidents, Dr. Kayser, Editor of the *Zeitschrift*, is at Hannover, and Dr. Defant is in Bavaria; Professor Krebs is in Vienna. The President, Excellens Schmidt-Ott is near Berlin.

Professor Troll's letter also contains the information that the military-geographic research station of the Deutsche Wehrmacht, had taken literature from many scientific institutes to Rheda in Westphalia. During the last stages of the war, this library, with its valuable collection of books and maps, was transferred to the farm of August Vechter at Eisbergen, near Rinteln on the Weser. It is now reported that the library has been moved to Bad Oeynhausen, or to Minden.

Major Davies, Lecturer in Geography at Leeds University, writing from a garrison north of Hamburg says that he has met Professor Mecking and Professor Termer of the University of Hamburg. He has heard that Professor Penck died during a bombing raid on Prague.

We have also received a recent list from Professor Wüst, now on the staff of the German Maritime Institute at Hamburg, giving details of the whereabouts of many German professors.

SURVEY IN THE COLONIES

In the second annual report of the Colonial Research Committee, appointed to advise on research schemes under the Colonial Development and Welfare Act, we note the encouraging progress made towards a scheme for the completion of the topographical and geological surveys of the Colonies. It is planned to set up a central organization to complete within ten years the whole of the geodetic and major framework and half of the outstanding topographical work remaining to be done in the Colonies. The work would be carried out on a regional basis, with provision for those Colonies not readily falling within a regional grouping. Full use would be made of air photography for topographical mapping, and it is stated that the Royal Air Force are prepared to carry out the necessary photography as part of their peace-time specialist training. The essence of the scheme is that it makes available a trained staff and expensive equipment which would be beyond the resources of individual Colonies. The Committee recommend the adoption of a scheme on similar lines for the execution of geological surveys, by which regional teams would work under a central organization. The importance for the future development of a Colony of completing as early as possible an accurate topographical survey on a sound geodetic framework has frequently been emphasized, and equal importance, as the Committee points out, should be given to geological survey, the value of which is not limited to mineral development but is fundamental for the systematic study of soil and water resources. Both these schemes have, it is understood, been submitted by the Secretary of State to the Colonial Governments for their observations, in the light of which final decisions will be taken.

Other sections of the report show the lines upon which the organization of colonial research is proceeding. The Colonial Research Committee submits advice on general policy and on the allocation of funds. One of its important functions is to initiate work on fundamental problems which do not fall entirely within the scope of specialist committees. Among these the main bodies at present are concerned with products, social research, and medical research, and to these a Committee for Colonial Agriculture, Animal Health, and Forestry Research is to be added.

MAPS FOR THE NORTH-EAST AFRICAN CAMPAIGN

Brigadier R. Ll. Brown, formerly the military Director of Survey, Middle East Forces, has drawn our attention to the remarks about maps at the end of

Brigadier Bagnold's paper, "The early work of the Long Range Desert Group" (*Geogr. J.* 105 (1945) 42). In particular he draws attention to the passage that reads: "The only small-scale map of the whole of north-east Africa the army had during the African campaign was made by Clayton shortly before his capture. It is still the only one in existence, as far as I know, which makes any pretence of showing the desert's main features." Brigadier Brown tells us that in several quarters this has been taken to mean literally that the army was given no useful maps except Clayton's on which to fight the African campaigns. He points out that were such an interpretation to receive any wide acceptance it would be most unfortunate, because it is untrue in fact and because such an interpretation would defeat the object of Brigadier Bagnold's remarks which was to show, quite rightly, that the L.R.D.G. operated over vast tracts of unsurveyed, unmapped terrain.

In view of Brigadier Brown's comments we are anxious to make clear, beyond possibility of doubt, that no reflection upon the valuable work of the Middle East Survey Service was intended. The facts as regards Major Clayton's map and the maps produced by the Service are as follows: Major Clayton's map was on the scale of 1/4M and was the best map available of the whole desert area on this very small scale. Its particular value for the work of the Long Range Desert Group was that it enabled the main features of a vast area to be studied as a whole, without reference to a number of sheets on a larger scale, a point of considerable importance in view of the great distances covered by the L.R.D.G.

The military Survey Service, on the other hand, produced many map series on various scales to meet the varied needs of the fighting services as a whole. Among their many services to the Ground and Air Forces the following may be cited as relevant to the general area of the campaigns in north-east Africa. Maps of that part of Egypt commonly known as the Western Desert were reproduced at the 1/100,000 scale from the excellent surveys of the Egyptian Survey Department, and they extended north and west from the Bahariya and Siwa oases to the Mediterranean and the Italian frontier. Similar maps of the surveyed parts of Libya were printed and made available. A large area, part of which later became the battle-field of El 'Alamein, was surveyed *de novo*, mainly by South African Survey Units, and issued at 1/50,000 scale; and this survey made no small contribution to the success of the artillery in that battle. A map series covering the whole area of major operations in north-east Africa on the scale of 1/250,000 was compiled and issued, and Rommel, who had captured some copies, paid it the compliment of ordering his troops to use it. A 1/500,000 series was also prepared incorporating the available Egyptian and Italian material and much new information from air photographs and other sources, including some valuable contributions by the L.R.D.G. A great number of special air maps and other special maps on larger scales were also produced for these areas of operation.

OBITUARY

CAPTAIN A. E. LIGHTBODY

Captain A. E. Lightbody, who died on 19 February 1945 in his eighty-third year, was one of the two surviving members of the FitzGerald Andes Expedition. His connection with our Society started as early as 1898, when he was first elected a Fellow. At the age of twenty-two he went to the Argentine to set up a sugar refining plant at Salta. Returning to that country as a railway engineer, he met the FitzGerald Expedition at Mendoza in 1896 and was persuaded to accompany them in their successful attempt on Aconcagua. Lightbody acted as photo-

grapher on the expedition as well as doing survey work and giving genera assistance through his knowledge of the country. Later he made a trip by steam launch up the Parana to the Iguassu Falls in northern Brazil. His diaries with accounts of these two expeditions, and photographs have been presented to our Society by his daughter. After assisting E. A. FitzGerald in writing up the results of the expedition, Lightbody travelled widely in Malta, Egypt, China, Japan, New Zealand, and Australia.

MEETINGS: SESSION 1944–45

Seventeenth Meeting, 14 May 1945. The President in the Chair

Elections: Squadron-Leader R. H. Brown, O.B.E., B.SC., R.A.F.; William Frank Burbridge; Peter Alec Florence; G. B. B. Foster; Captain Richard Frazer Busby Hoskyn, R.N. (Ret.); Charles Edward Lee; Captain William Joseph Mulgrew, I.A.O.C.; Henry Edward Nicholls; Captain C. Hamish Pelham-Burn; William Percival Richards; Major J. O. M. Roberts, I.A.; Clayton M. Rowe; Edward Simmonds; Malcolm John Leggoe Uren

Paper: Centenary of the sailing of Sir John Franklin with the *Erebus* and *Terror*. By Dr. Richard Cyriax and Mr. J. M. Wordie

Eighteenth Meeting, 28 May 1945. The President in the Chair

Paper: A simple instrument for finding position. By Lieut.-Col. E. H. Thompson

Nineteenth Meeting, 11 June 1945. The President in the Chair

Elections: Miss Kathleen Mary Beech; Vincent Brennan, M.B.E.; Leslie Robert William Day, M.A.; Lieut. George Henry Ord Dines, R.N.R.; Rev. Ambrose Samuel Else; Major Ralph Edward Amyas James; John Leonard Oliver, B.SC.; Wing-Commander Anthony John Mander Smyth, O.B.E., D.F.C.; Rev. Gilbert Griffith Thomas, C.F.

Paper: Journeys in Luristan. By Dr. J. V. Harrison

ELECTIONS

The following have been elected Fellows of the Society:

On 25 June 1945: Herbert Percy Arnold-Craft; Rev. Anderson Bakewell, S.J.; Major Fred James Frost; H. Gledhill; Major Albert William Godfrey; John F. Haydon; Geoffrey Edward Hutchings, F.G.S.; Squadron-Leader Ian Alasdair MacDonald, R.A.F.; Miss Brenda Muriel Stead

On 23 July 1945: James Whirter Renwick Adams; James Joseph Branigan, M.A.; Lieut. Harry Calder, R.E.; Peter Kenneth Clark; Lieut. Geoffrey Charles David, R.N.; Mrs. Mary Evered Douglas, O.B.E.; Lieut.-Col. Walter George Hingston; Captain Francis Joseph Jefferson; Sub/Lieut. Arnold Clive Jones, R.N.V.R.; Captain David Carol MacDonell Mather; Wilfrid Devereux Price; Kenneth Robinson; Miss Edith M. Shepperd (Sister M. Ursula); Miss M. Dorothy Smallwood, B.A.; Sir Lionel Smith-Gordon, Bt.; 2/Lieut. Howard Peters Stone, R.E.

On 13 August 1945: Rev. George Armstrong, C.F.; Captain Frederick St. Julien Barber; Captain Ellis Frank Brooke, R.A.; Rev. Ivo Francis Henry Carr-Gregg, M.A., F.R.A.S.; Miss Hilda Russell Cruise, B.A.; John Davis; Mrs. E. H. Grainger; Captain Samuel Thomas Adrian Hall, R.A.; James M. Houston, M.A.; Miss Doris Melinda Johnson; Lieut.-Col. William McDonald Porter, R. Signals

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